Annual Report for the Russian River Coho Salmon Captive Broodstock Program: Hatchery Operations and Monitoring Activities

July 2004 – June 2005

prepared by

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Table of Contents

List of Tables

Page

List of Figures

I. Introduction

I.A. Population status of the Central California Coast Coho (CCC) Salmon Evolutionary Significant Unit (ESU)

I.A.1. Federal and State listing status

The CCC coho salmon ESU was listed as threatened under the federal Endangered Species Act in 1996. In response to a recommendation from the Biological Review Team conducting a comprehensive status review of Pacific Coast salmon populations, the National Marine Fisheries Service changed the CCC coho salmon ESU listing from threatened to endangered on June 28th, 2005 (70 FR 37160). The CCC coho ESU has been listed as endangered under the California Endangered Species Act since August of 2002.

I.A.2. Presence of wild coho salmon in the Russian River Drainage

Since 2001, juvenile coho presence has been confirmed in only five of the 32 historic coho streams (referenced in Brown & Moyle, 1994). Presence data collected during broodstock collection efforts and monitoring survey work indicates that wild juvenile coho salmon are present in these creeks (Green Valley, Dutch Bill, Mark West, Redwood and Felta Creeks) in low numbers and in general, were only present in intermittent years. Coho salmon were present in Green Valley Creek every year from 2001 through 2004, although very few fish were found in 2004. Since the inception of the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) in 2001, individual year classes of wild coho salmon have declined in Green Valley Creek and the number of wild juveniles available for broodstock collection dropped from greater than 300 fish to less than 10 individuals in 2004.

I.B. The Russian River Coho Salmon Captive Broodstock Program (RRCSCBP): Goals & Background

I.B.1. Hatchery Component

The California Department of Fish & Game (CDFG), National Oceanic & Atmospheric Administration (NOAA Fisheries), and the US Army Corps of Engineers (USACE) initiated the RRCSCBP in 2001 with the goal of re-establishing self-sustaining runs of coho salmon in tributary streams within the Russian River basin. Broodstock are captured as juveniles from tributaries to the Russian River, and raised to maturity at the Don Clausen/Warm Springs Fish Hatchery (WSH). Offspring of these captive-reared broodstock are stocked as juveniles within their historic range. These fish are released at two different stages during their freshwater rearing phase (spring and fall after hatching), such that they spend 6-12 months in freshwater before emigrating to the ocean. This staggered release strategy allows for an assessment of juvenile oversummer survival in each release stream, while maintaining a portion of the progeny population in captivity to be released after the dry summer months.

I.B.2. Monitoring Component

The University of California Cooperative Extension (UCCE) and California Sea Grant Program have been working with agency partners to develop and implement a monitoring and evaluation component for the RRCSCBP. The primary monitoring goal is to evaluate the effectiveness of the RRCSCBP by documenting whether released program fish return to their streams of release as adults and successfully complete their life cycles. Different hatchery release protocols and stocking environments will be assessed to determine the optimal stocking strategies for successfully restoring coho to the Russian River drainage. Specific monitoring objectives for each release stream include estimating seasonal instream abundance and survival of spring and fall-released coho, estimating adult return rates and juvenile to adult survival rates, measuring coho size and condition, and documenting food availability, baseline flow, and temperature regimes. All of these biotic and abiotic metrics are compared among the different program streams. With this information, agencies will have the ability to make informed decisions about the future direction of the program and adaptively manage release strategies for optimal survival. Results from monitoring efforts are routinely reported at Monitoring and Evaluation Committee (M&E Committee) meetings. The M&E Committee (representing county, state, and federal agencies, non-governmental organizations, and public and private parties), in turn, provides feedback and suggestions about how to improve the monitoring program, and the RRCSCBP in general.

Part I: Hatchery Operations

II. Broodstock Collection & Rearing

II.A. Collection methods and results

II.A.1. Collection methods

The sole capture method in the summer of 2004 was the use of one-person hand seines in a team of 3-5 people. As most pools in Green Valley Creek were deemed likely to dry completely, all juvenile coho captured were retained and transported to WSH for broodstock. In the spring of 2005, natural-origin coho were discovered in Mill and Felta Creeks when young-of-the-year coho were captured in the UCCE-operated outmigrant trap on Mill Creek. The presence of coho in this drainage had not been documented in recent years. The Coho Salmon Recovery Hatchery (CSRH) Committee elected to incorporate juvenile coho captured in this trap into the broodstock population for the RRCSCBP. The number of fish retained and transported to WSH was dependent on the number of fish captured on a given day: if ≤ 5 juvenile coho were caught, all fish would be transported to WSH; if the number caught was > 5 fish and ≤10 fish, then 5 fish would be transported to WSH; if >10 fish were caught on a given day, 50% of all fish would be transported to WSH up to a total of 10 fish.

II.A.2. Summer 2004 – spring 2005 broodstock collection results

The results of broodstock capture activities from July 1, 2004 through June 30, 2005 are summarized in Table 1. Juveniles captured from Green Valley Creek ranged from 90 – 109 mm fork length on the day of collection. Due to the low number of wild coho captured for Brood Year (BY) 2003, the broodstock population was supplemented with captive-origin coho, all progeny of BY2000. 297 juveniles from this group were retained. The process of selecting fish for this purpose, designed to achieve full representation of all family groups present in the population, is detailed in Conrad, 2005, Appendix II.

Table 1. Broodstock collection, July 1 2004 – June 30 2005.

Source	Capture Method	Collection Date(s)	Brood Year 2003	Brood Year 2004
Green Valley Creek	Hand-seines	8/13, 8/18, 9/3 2004	7	0
Mill Creek	Outmigrant Trap	4/18, 4/20, 4/24, 5/31 2005	0	4

II.B. Broodstock rearing

II.B.1. Initial treatment

All newly collected broodstock were placed in quarantine upon arrival to WSH. Before combination with other broodstock, the fish were treated with an 8-hr, 70 ppm oxytetracycline bath. One day after the oxytetracycline treatment, the fish received a one hour, 170 ppm formalin treatment for three consecutive days.

II.B.2. Trough rearing

While still in the juvenile stage and before receiving a Passive Integrated Transponder (PIT) tag, broodstock are housed in indoor troughs, with dimension of 16'L x 3'W, with the water depth maintained at approximately 16". The maximum loading density in these tanks prior to transferring broodstock to the larger circular tanks was approximately 0.3 lbs fish/ft^3. During this early rearing period, the fish are fed BioOregeon BioDiet Grower semi-moist feed at a rate of 2-4% of their body weight.

The only special treatment applied to fish during this rearing period is the Renogen vaccine for Bacteria Kidney Disease (BKD) (described in detail in the Conrad, 2005, section C.7.1).

II.B.3. Circular tank rearing

In the early spring after their arrival at WSH (approximately nine months after capture), broodstock were transferred to large circular tanks for the remainder of their rearing period. During this reporting period, WSH had six circular tanks (20' diameter, with the water depth maintained at approximately 4'). Once in the circular tanks, all brood years were fed at 2% of their body weight until about two months before their anticipated spawn date. Their diet was made up entirely of semi-moist brood diet pellets from BioOregon, Inc., with the exception of a portion of BY 2002 that were fed frozen krill (see notes on BY 2002, below). All fish residing in circular tanks were inventoried, weighed, and measured on a quarterly basis. Broodstock growth data collected for the RRCSCBP from its inception to the end of this reporting period are summarized in Appendix I.

During the summer months (June – September), each tank received a 170 ppm formalin treatment for one hour at three-week intervals. The broodstock were not fed the day prior or the day of treatment. This treatment was a prophylactic measure against outbreaks of fungus or *Ich*. The concern regarding both of these pathogens is generally greater in the summer months, when water temperature is slightly warmer (Figure 1) and the untreated, unfiltered water that is presently used for broodstock rearing is more likely to contain fungus or other parasites.

Specific rearing notes for each brood year relevant to the reporting period are included below.

<u>BY 2001</u>

BY 2001 was divided between two tanks from July, 2004 until their spawning season the following winter. The maximum loading density (estimated in October 2004 when the fish were at their largest size prior to spawning) was approximately 0.53 lbs fish/ft^3.

Sonographic examination was conducted during a routine inventory on September 28 and 29, 2004 in order to determine the gender of each fish. These examinations revealed that BY 2001 was comprised of 122 females, 120 males, and 1 fish whose gonads were not distinguishable from the ultrasound image. The gender of each individual fish was sent to Dr. Carlos Garza at the NOAA Fisheries Southwest Fisheries Science Center shortly after the sonograms were performed for the purpose of constructing the breeding matrix.
The erythromycin injection, a preventative measure against maternal transmission of BKD to offspring, was applied to all females on November 17, 2004. Ripeness sorts and spawning began on December 2, 2004. The protocols and summary of ripeness sorts and spawn events for BY 2001 are provided below (Section III).

BY 2002

BY 2002 was reared in two circular tanks until April of 2005, when they were divided among three tanks, such that there were about 100 fish/tank. Before thinning, the maximum loading density in each tank was 0.30 lbs fish/ft^3. The decision to reduce the tank density by using an additional tank was based on the availability of a third tank, and the speculation that reduced density would reduce stress and encourage growth. In June of 2005, the loading density had returned to pre-thinning levels due to the rapid growth of the broodstock.

In the spring of 2005, WSH received a donation of frozen krill from Bodega Marine Lab. As broodstock diet is known to have direct effects on gamete quality (Izquierdo, 2001), and as krill is a common food item for coho salmon during their ocean residency, this donation presented an opportunity to compare growth and reproductive success between fish fed only commercial pellet feeds and those fed a species-appropriate natural food as a part of their ration. Beginning on June 16, 2005, krill comprised 60% of the ration for one tank, with the remaining 40% comprised of Bio-Oregon semi-moist pellet feed. Krill was top-coated with a mixture of cod liver oil and vitamins, based on recommendations from Dr. Kristen Arkush, Bodega Marine Laboratory (BML). As we did not have enough tanks to create replicate groups for each diet, this comparison served as a pilot investigation into the possible benefits to reproductive performance of including krill in the broodstock diet. Results of this comparison will be reported in the 2005-2006 RRCSCBP Annual Report.

BY 2003

BY 2003 was PIT-tagged on January 31, 2005 and February 2, 2005. Each fish was anesthetized in a bath of 60 ppm tricaine methanesulfonate (MS-222). Fin tissue samples for genetic analysis were taken at the same time the PIT-tag was inserted, and subsequently stored in an envelope labeled with the PIT-tag number. The average fish size at the time of PIT tagging was 144 mm fork length (FL) and weighed 43 g. One post-tagging mortality occurred on February 18, 2005. This mortality was apparently directly related the PIT-tag insertion, as a puncture wound was observed in the stomach during necropsy.

BY 2003 received the Renogen vaccine on March 7, 2005. On March 14, 2005, these fish were transferred from starter troughs to circular tanks. This brood year is comprised almost entirely of captive-origin fish (spawned at WSH in the winter of 2003-04 from wild broodstock). Because the spawn dates for these fish were dispersed between December 2003 and March 2004, there was significant variation in body size. To control size-related aggression and competition within tanks, these fish were separated into two different tanks, with one tank holding the larger fish and the other containing only the smaller size class. Also, a full ration was offered to the larger size class only three days/week, while the tank containing the smaller size class was fed daily. This feeding schedule continued until August, 2005. The different feeding schedules eventually allowed a transfer of fish that were originally from the smaller size group into the larger size group, in order to have equal numbers of fish in each tank. Maximum loading density for this brood year during the reporting period was 0.04 lbs fish/ft^3, in June, 2005.

II. B. 4 Water quality

The following data (except those for temperature) are the results of water quality tests conducted at the Department of Fish and Game Water Pollution Control Laboratory (Rancho

Cordova, CA) on samples taken from the influent to the facility. Effluent samples are also tested, but not reported.

Dissolved oxygen (DO)

The DO concentration ranged from 10.3 mg/l (August 15, 2004) to 12.6 mg/l (May 1, 2005 and June 15, 2005).

Water temperature

Water temperature is an influential environmental factor with regard to both the success of gamete development and the timing of final maturation. As the temperature at the hatchery varies with the water temperature of Lake Sonoma (there is no equipment in place to control water temperature), it was important to develop accurate estimates of average temperature over time, and understand how the water temperature fluctuates seasonally.

Water temperature was measured with a data logging device placed in one of the large circular tanks. The temperature was logged every hour, enabling a calculation of average daily temperature. The mean daily temperatures for each month from July 2004 through June 2005 are depicted in Figure 1. The highest temperatures for the reporting period took place in July 2004, with a maximum temperature reading of 14.8°C on July 19, 2004 between 1600 and 1800 hrs. The coldest temperature reading of 9.4°C was on April 8, 2005.

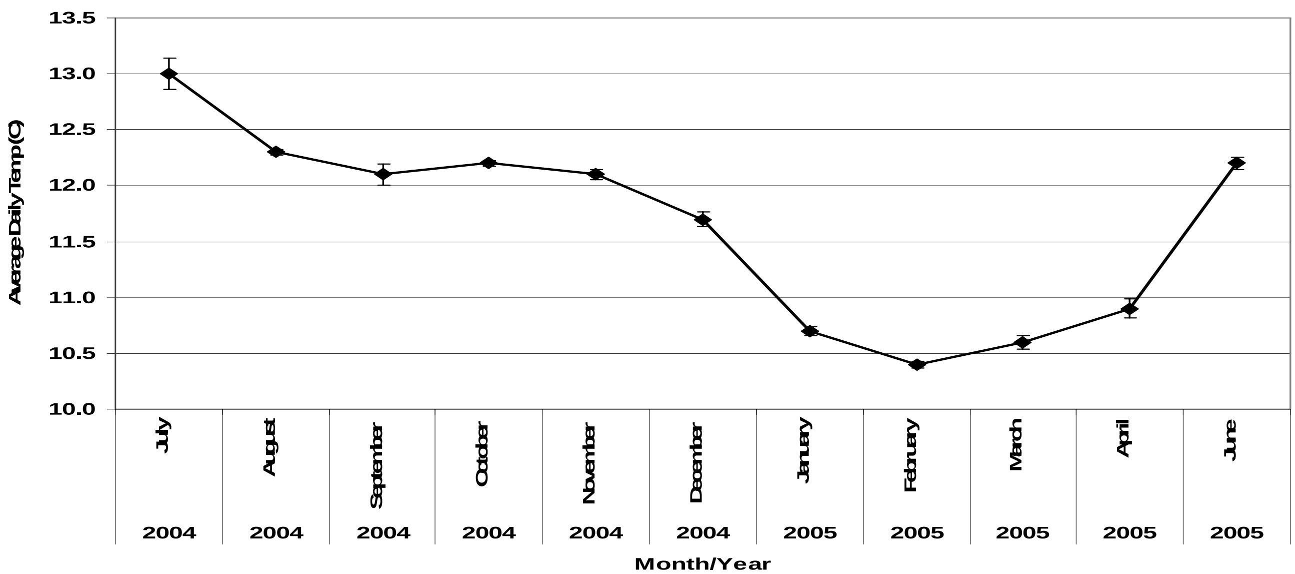

Figure 1. Mean daily temperature (°C) by month for circular tanks housing broodstock.

Turbidity

Turbidity, measured in nephelometric turbidity units (NTUs) ranged from 4.1 NTU (December 1, 2004) to 7.8 NTU (September 1, 2004).

II.C. Broodstock pre-spawning mortality rates

II.C.1 Necropsy protocol and summary of pre-spawning mortalities

All tanks containing broodstock were visually checked for moribund or otherwise compromised fish on a daily basis. Any fish with visible health issues was quarantined, treated as necessary, and replaced into the main broodstock population only when it was deemed safe to do so. A necropsy was performed on any broodstock found dead. Tissue samples collected during necropsy were preserved in a 10% formalin solution and given to CDFG pathology staff for histological analysis.

Table 2 provides a synopsis of pre-spawning mortalities that occurred during the reporting period. Overall, the percentage of pre-spawn mortalities attributed to fungus was 24%, which was an improvement from the 35% of pre-spawn mortalities attributed to fungus in the prior reporting period (Conrad, 2005).

The overall pre-spawning mortality rate for BY 2001, spawned during the winter of 2004-2005 was 12.8% (59 fish of the original 462 fish collected). The single fish that died from a condition called urolithiasis, (Dr. William Cox, CDFG pathologist, pers. comm.) was unusual and the condition has not been a recurring problem. Since the program has been in operation, an increase in pre-spawn mortalities has been observed in September/October of every year, generally focused on the brood year due to spawn the following winter (Figure 2). Most of the mortalities of these 2+-aged fish have not had an obvious cause (e.g., there were no external or internal abnormalities). The fact that the increase in mortality each fall has been limited to the 2+-aged fish suggests that the cause may be related to the process of sexual maturation that is occurring at the same time. The notable peak in mortality in April and May of 2004 for BY2001 (Figure 2) was due to a fungus outbreak (reported in the 2004 AR).

Table 2. Pre-spawn mortalities occurring between July 1, 2004 and June 30, 2005, categorized by presumed cause.

Brood Year	Origin	Fungus	Trauma	Urolithiasis	Unknown	Total
2000	Olema Ck.	0	0	0	1	**1**
2001	Green Valley Ck.	3	1	0	4	**13**
	Dutch Bill Ck.	1	1	0	1	
	Olema/Blue Line Ck.	1	1	0	0	
2002	Green Valley Ck.	0	1	1	3	**6**
	Olema/Blue Line Ck.	0	1	0	0	
2003	Captive	0	1	0	0	**1**
	Total	**5**	**6**	**1**	**9**	**21**

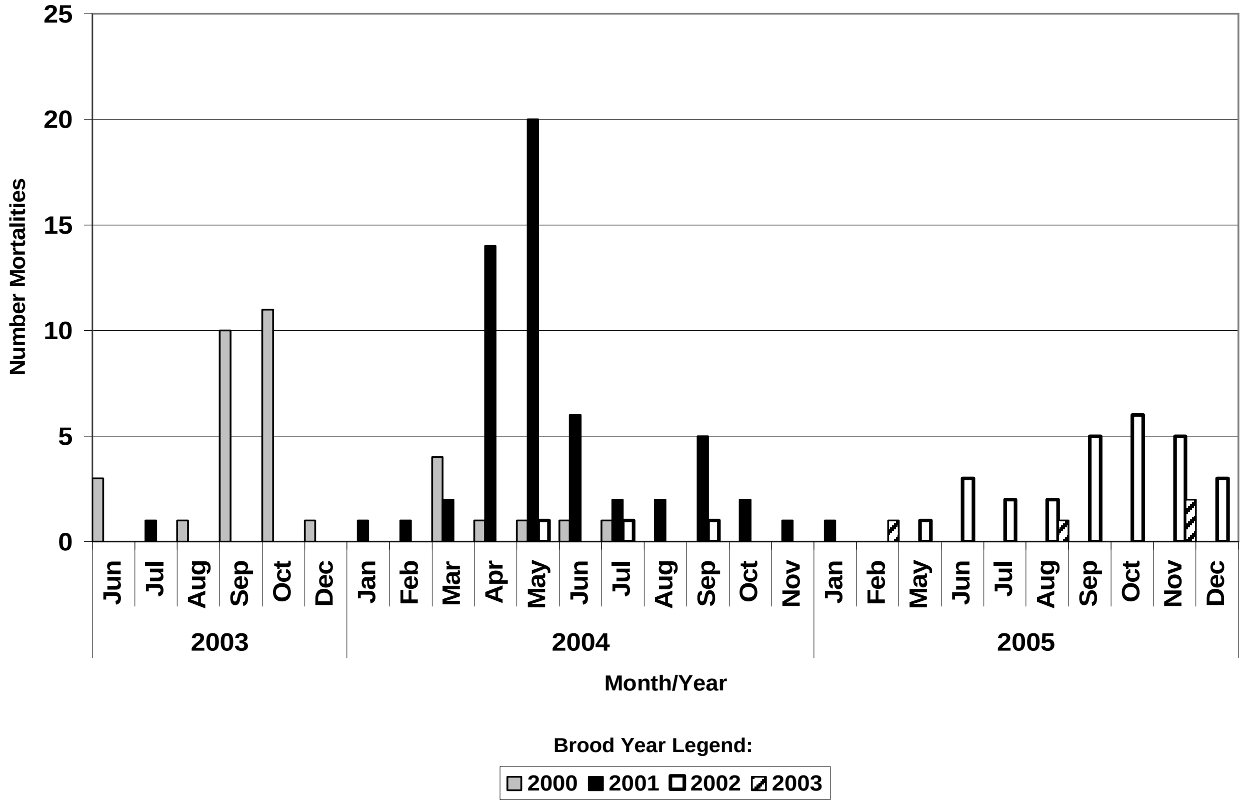

Figure 2. Temporal trend in pre-spawn mortalities for each brood year through December, 2005.

III. Broodstock Spawning: BY2001

III.A. Results of genetic analysis for BY 2001

III.A.1. Breeding matrices for Russian River stocks and comparison of Marin and Russian River stocks

The Russian River BY 2001 was comprised entirely of fish collected from the wild from two distinct tributaries within the Russian River basin: Green Valley Creek (234) and Dutch Bill Creek (78). Analysis completed at the Southwest Fisheries Science Center (SWFSC) by Dr. Carlos Garza and Elizabeth Gilbert-Horvath showed that these two Russian River populations were distinct from one another (Garza, pers. comm.). Due to the genetic distance between them interbreeding between these two groups in captivity was not recommended. Two separate breeding matrices were provided for Green Valley and Dutch Bill broodstock. These breeding matrices guided the pairing of males and females during spawning such that breeding individuals related at the level of a half-sibling could be avoided. However, progeny from the Green Valley and Dutch Bill spawning groups were not maintained separately, as it was deemed beneficial to represent the entire range of diversity at each stocking location.

In addition, at the beginning of the 2004-05 spawn season, WSH was still maintaining two brood years (BYs 2001 and 2002) from the Lagunitas/Olema population, collected as part of the original capture protocol (described in the Conrad, 2005, section A.2). As genetic analysis comparing the Russian River and Lagunitas/Olema populations continued to show dissimilarity between the two groups for BY 2001, it was again not recommended that the RRCSCBP interbreed these two groups in captivity (Garza, pers. comm.).

III.A.2. Disposition of BY 2001 Lagunitas/Olema coho held at WSH

The CSRH Committee elected to devote a portion of the BY 2001 and BY 2002 Lagunitas/Olema Creek broodstock that were residing at WSH to research on environmental factors controlling the timing and success of broodstock reproduction. These studies would provide guidelines for photoperiod schedules and temperature regimes necessary for successful reproduction for Russian River broodstock at WSH. The salmon facility at BML presented an ideal location for this research as it was already equipped with adult rearing and spawning facilities for salmon, as well as staff with the necessary expertise. The portion of each brood year that was not used for research will be released as adults in Walker Creek for supplementation purposes, as was done with the first brood year collected from the Lagunitas/Olema system (BY 2000).

On August 10, 2004 forty BY 2001 Lagunitas/Olema broodstock (30 female, 10 male, gender determined via sonographic examination) were transferred to BML for a study on the effect of photoperiod manipulation on spawn timing and gamete quality.

On March 29, 2005, forty BY 2002 Lagunitas/Olema subadults (30 females, 10 males, gender determined via genetic analysis done at the SWFSC) were transferred to Bodega Marine Laboratory (BML) for the purpose of a study on the effect of rearing temperature on broodstock performance. Half of each gender was reared at 11°C, while the other half was reared at 14°C. These experimental groups will continue to be reared at these temperatures until their spawning in the winter of 2005-06. The results of both the photoperiod manipulation and rearing temperature studies are summarized in separate documents, submitted to CDFG and NOAA Fisheries by Dr. Kristen Arkush.

On December 7, 2004, the 86 remaining adult BY 2001 Lagunitas/Olema Creek fish still residing at WSH were outplanted in Walker Creek. There were no mortalities during the transfer. This was the second consecutive year of outplanting adult coho into Walker Creek. In the summer of 2004, about six months after the first planting of adult coho in Walker Creek and their presumed spawning, CDFG biologists collected fin tissue samples from 7 juvenile coho from Salmon Creek, a tributary to Walker Creek and from the Walker/Chileno Creek confluence. Genetic analysis carried out at the SWFSC genetics lab revealed that all samples were from fish spawned from the adults released in the winter of 2003-04 and all 7 samples were from the same mating pair, (Garza, pers. comm.).

III.B. Ripeness sort and spawning methods

III.B.1. Ripeness sort

Unlike the 2003-04 spawning season, males and females due to spawn were not separated into different tanks. Instead, on the same day as the erythromycin injections were administered to the females (November 17, 2004), BY 2001 was sorted into two groups: one group was deemed ready to spawn early in the season (“early”), and the other group was deemed not ready to spawn until later in the season ("late"). This distinction was based on a subjective assessment of the development of secondary sexual characteristics. A benefit of these sorting criteria was that we minimized handling on a portion of the fish. After December 1, we began sorting through the "early" group of spawners to find ripe fish. The "late" group was sorted only every 10-14 days.

A second change in the ripeness sorting protocol from the 2003-04 spawning season was the use of hormone implants that contain a synthetic analogue of salmon gonadotropin releasing hormone (GnRH). The implant (Ovaplant) is obtained from Syndel International, Inc., and contains 75 µg of GnRH. GnRH is a hormone naturally released from the pituitary in the salmon brain during the ~4 week period prior to spawning. Once released, GnRH initiates a series of endocrine events that result in the final maturation and release of gametes (Swanson, 1995). In the wild, the release of GnRH is cued by changes in the environment, usually with respect to water temperature and photoperiod. In captivity, the fishes' environment does not always mimic the natural situation and in many cases, captive broodstock mature asynchronously or significantly later than wild-spawning populations (Swanson, 1995). The use of GnRH implants can counteract this problem by inducing the endocrine changes that prepare the fish for spawning, such that broodstock are spawned in a synchronous fashion.

During weekly ripeness sorts, comments were recorded on the maturation progress of individual fish. During every sorting event, previous comments on each individual were reviewed and used as part of the criteria for deciding whether to use an implant. In general, Ovaplant was used on both males and females that showed signs of final maturation (e.g., color changes, abdominal softness in the case of females, protrusion of the vent), but had not completed the final maturation process (gamete release) for at least two weeks. In some cases, GnRH implants were administered to males that were expressing milt in small quantities in order to enhance milt volume. Ovaplant was administered in a non-sterile injection to the dorsal sinus.

All sorting events took place at the circular tanks. Fish that were not yet ready to spawn were returned to the circular tank. Males that were expressing milt were given an external disc-tag label. These labels provided an externally visible number inserted through the intramuscular tissue beneath the dorsal fin. This external number facilitated the location of individual fish during spawning activities. Once disc-tagged, the fish were transferred to the spawning area (located indoors) in an aerated cooler. Females that were deemed ready to spawn within one week were not disc-tagged, but were transported in the same manner from the circular tanks to the spawning area.

III.B.2. Spawning

Four males were spawned with each female, as long as four males within the breeding matrix's list of favorable males for the given female were available. Individual males were not spawned more than five times, in an effort to incorporate all the broodstock into the breeding population. When space allowed, eggs from individual females were separated according to the male parent and these full-sibling groups were incubated separately. However, separation of full-sibling groups was only feasible with approximately half of the females. At a minimum, eggs from each female's spawn were incubated separately (half-sibling groups) in order to obtain fertilization, hatch, and swim-up rates for each female's eggs. Progeny were combined at the fry stage. In addition to the Heath incubation trays, hatching jars were also used for incubation of eleven females' eggs during the initial three weeks of incubation (prior to eye-up). These jars were used to determine whether egg mortality from fungus was reduced compared to eggs incubated in the Heath-tray system.

Formalin treatment was introduced to the egg incubation protocol during the 2004-05 spawning season. During the first half of the spawning season, eggs were not treated at all during incubation, and suffered significant losses due to fungus. Mid-way through the season, we began a daily formalin treatment regimen of 1600 ppm for fifteen minutes. Formalin treatment was discontinued once eggs reached the eyed stage. During the eyed stage, dead eggs were removed and enumerated daily. Since we started this treatment schedule mid-way through the spawning season, the number of days any given lot of eggs received treatment was variable, ranging from 0 to 20 days. The variation in egg treatment over the course of the spawning season introduced a confounding factor to comparisons of reproductive success between spawning groups (e.g. reproductive success of Dutch Bill Creek and Green Valley Creek females).

III.C. BY 2001 Spawn event results

A total of 111 females were spawned between December 14, 2005 and January 19, 2006. Individual females' spawning data and their male spawning partners are detailed in Appendix II. A total of 229,704 eggs were taken, resulting in the final production and release of 26,059 juvenile coho salmon.

III.C.1. Comparison of BY 2000 and BY 2001 female reproductive success

The average body size, female fecundity and egg survival rate to the eyed stage were dramatically improved compared to BY 2000 (Table 3). However, the percentage of eyed eggs that successfully hatched was significantly lower among BY 2001 females compared to BY 2000 females. However, hatch rates were determined for only 18 BY 2000 females, while during the BY2001 spawning season, hatch rates were calculated for 100 females.

Table 3. Comparison of mean values (standard error) in basic reproduction variables between BY2000 and BY2001 females.

	BY 2000 Females	**BY 2001 Females**
Spawn Fork Length (FL) (mm)	461 (3)	558 (4)
Spawn Weight (g)	1130 (31)	2294 (48)
Fecundity (no. eggs/female)[1]	1160 (49)	2070 (74)
% Egg Survival to Eyed Stage	12 (3)	36 (3)
% Hatch from Eyed Eggs	59 (5)	34 (2)

III.C.2. Comparison of reproductive success between Dutch Bill and Green Valley Creek BY 2001 stocks

Of the 111 BY 2001 females spawned, 23 were of Dutch Bill Creek origin and 88 were from Green Valley Creek. During the majority of the pre-spawning rearing period, these fish were reared in the same tanks, such that there were no differences in rearing density, feeding rates, or nutrition between fish of different origin. However, we observed that females from Dutch Bill Creek were significantly larger, had greater fecundity, and produced smaller eggs than females from Green Valley Creek. In general, eggs from Green Valley Creek females survived at a

[1] Fecundity estimate: This number is based on the eggs that were extracted from individual females and used for fertilization, and does not include non-ovulated eggs (attached to ovarian tissue). The fecundity estimates reported in Table 3 do not necessarily reflect total fecundity.

higher rate to the eyed stage than eggs from Dutch Bill Creek females, but the reverse was true of egg survival from the eyed stage to hatching (Table 4). It was difficult to determine whether the differences in egg survival rates were due to a) maternal creek origin, or b) differential number of days that eggs received formalin treatment. Overall, it appeared that formalin treatment had a positive effect on egg survival rates to the eyed stage, but this trend was only clear among the Green Valley Creek females. Among the Dutch Bill Creek females, egg survival to the eyed stage improved when eggs were treated between 1 and 7 days, but declined again when eggs received 13 to 20 formalin treatment days (Figure 3).

Table 4. Comparison of mean values (standard error) in basic reproduction parameters between BY 2001 females from Dutch Bill and Green Valley Creeks.

	Dutch Bill Creek Females	*Green Valley Creek Females*
No. Spawned	23	88
Spawn FL (mm)	577 (10)	554 (4)
Spawn Wt. (g)	2624 (125)	2205 (48)
Fecundity (no. eggs/female)	2990 (180)	1819 (56)
Specific fecundity (no. eggs/g body weight)	1.47 (0.11)	1.01 (0.03)
Average Egg Weight (g)	0.18 (0.01)	0.21 (<0.01)
% Egg Survival to Eyed Stage	32 (6)	41 (3)
% Hatch from Eyed Eggs	42 (6)	36 (3)

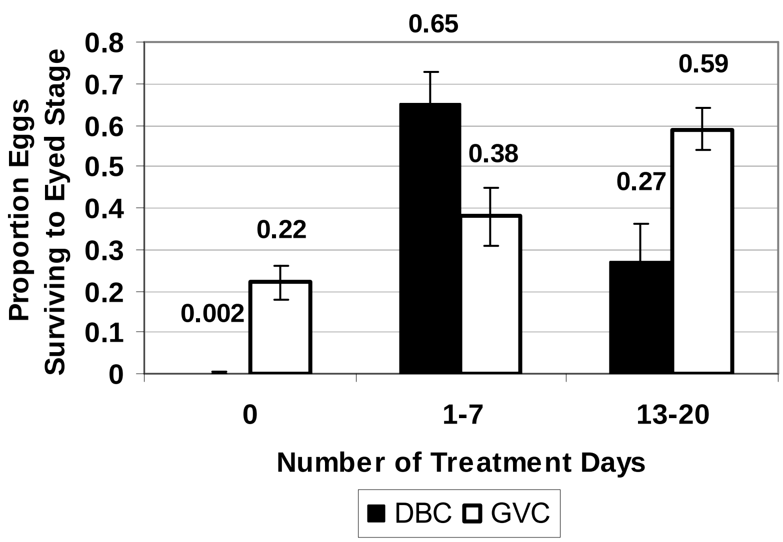

Figure 3. Proportion of eggs surviving to the eyed stage, categorized by maternal creek origin and number of formalin treatment days during incubation. DBC = Dutch Bill Creek; GVC = Green Valley Creek. For Dutch Bill Creek females, 5, 7, and 4 females received 0, 1-7, and 13-20 days of formalin treatment, respectively. For Green Valley Creek females, 34, 21, and 29 females received 1, 1-7, and 13-20 days of treatment, respectively. The remaining 11 females' eggs were incubated in a hatching jar, and thus are not included in this figure.

III.C.3. Comparison of reproductive success between GnRH-treated females and non-GnRH treated females

Although Swanson (1995) and Powell, et al. (1998) showed that injecting or implanting GnRH during the final maturation process did not result in differences in gamete quality between treated and untreated fish, it was worthwhile to compare reproductive success between GnRH-treated and untreated BY 2001 females since this was the first year that hormone implants were used for the RRCSCBP. Table 5 provides a summary of the number of males and females that received Ovaplant, as well as average values for basic parameters of reproductive success for females in each group. A comparison in the percentage of eggs surviving to the eyed stage shows that eggs from GnRH-treated females actually survived at nearly double the rate of eggs from untreated females. However, these results were again confounded by the number of days each lot of eggs received formalin treatment during the first three weeks of incubation. In fact, eggs from only 13 of the 30 untreated females received formalin treatment, while 48 of the 58 treated females received formalin treatment. Given that formalin treatment generally improved egg survival, this difference in the number of formalin treatment days between GnRH treated and untreated eggs may account for the difference in egg survival rates.

Table 5. Number of untreated and GnRH treated BY 2001 males and females, and comparison of mean values (standard error) of basic reproductive parameters between untreated and GnRH treated females.

	Non-GnRH treated	**GnRH treated**
No. Females	43	58
No. Males	67	50
Fecundity (# eggs/female)	1816 (93)	2044 (86)
Ave. Egg Wt (g)	0.22 (<0.00)	0.19 (<0.00)
% Egg Survival to Eyed	26 (4)	45 (4)
% Hatch from Eyed Eggs	33 (4)	38 (4)
No. egg lots receiving >0 days formalin treatment	13	48

III.C.4. Cryopreservation

Milt was sampled from ten BY 2001 males for gamete cryopreservation. The protocol for cryopreservation is described in Conrad, 2005. During the BY 2001 spawning season, there was no need to use cryopreserved milt samples for egg fertilization, as there was no shortage of milt from live males. Appendix II provides the identities of males used for cryopreservation.

IV. Progeny Rearing, Marking, and Release

IV.A. Juvenile rearing

Once fry in the Heath incubator trays had absorbed their yolk-sac and were ready to commence feeding, they were transferred to the rearing tanks described in section II.B.2. The transfer from incubator stacks to rearing troughs was the point at which progeny from single females were combined and survival rates of individual family groups could no longer be tracked. In order to ensure that final release groups contained fish from each family group created, all family groups were divided among multiple rearing troughs. After final determination of release numbers for each release stream, a portion of the fish for each release group was selected from each group of families created during transfer to rearing troughs in order to produce the total number of fish required for each release group.

Beyond basic family representation, another concern is the variation in family size within each release group. Variation in family size reduces the variance effective population size by increasing the likelihood that only a small proportion of the genetic diversity in the parent population will be represented in the ensuing generation. Thus, high variation in family size may jeopardize long-term population persistence. Results of the BY 2001 spawning indicated an average family size of 377 juveniles, with a range from 1 to >2000 fish per family. In response to the wide range in family size, a protocol was devised to reduce some of the variation in family size within juvenile release groups, without culling fish from the largest families. All families comprised of 500 or fewer fish were divided into four equal groups. Any family consisting of 500 or more fish was divided into five groups: 125 fish were combined with each of the four groups containing all families produced, and any fish remaining (in excess of 500 fish) were placed into a fifth group. Hence, this latter group contained only fish from the large (>500 fish) family groups, while the first four groups contained fish from all families created. In this way, the variation in family size within the four groups that included all families was reduced. The CSRH Committee determined that the group of fish consisting of only the large family groups would be released into separate streams from the groups containing all family groups.

Once all the progeny had been set out to rearing troughs, they were fed a diet of BioOregon Starter and Grower pellets at an approximate rate of 3-4% of their body weight. A subset of fish in each trough was weighed and measured approximately every three weeks. The body size data were used to adjust feeding rates for each trough in order to release the fish at a size similar to wild fish of the same age. Since juveniles in captivity generally grow at an accelerated rate, the feeding schedule was changed to only three feeding days/week in the late spring, to avoid releasing fish that are significantly larger than wild coho of similar age. For the progeny of BY 2001, scheduled for release in the spring and fall of 2005, this feeding schedule began on May 24, 2005.

IV.B. Juvenile tagging and release

IV.B.1. Fall 2004 release

<u>Release tributaries</u>

The RRCSCBP Committees identified three Russian River tributaries in which to release offspring of brood year 2000. These tributaries (Mill, Ward, and Sheephouse Creeks) were selected for reintroduction of coho based on habitat suitability, minimal land use threats, cooperative landowners, and high potential for successful monitoring and evaluation. The three tributaries are located in different geographic locations, entering the mainstem of the Russian River at varying distances from the estuary.

<u>Tagging</u>

All coho released in the fall of 2004 received an adipose fin clip so that they could be visually distinguished from offspring of naturally spawned fish during RRCSCBP monitoring activities. In addition, all juveniles received a coded wire tag (CWT) in the snout that was numbered sequentially in order to enable identification of release stream upon recovery.

Release summary

The 2004 release took place between October 4, and November 4, 2004. A total of 6,160 fish were released. Details of release numbers and average body size at the time of release are provided in Table 6. Prior to release, a survey of all potential release pools was conducted, data on habitat surface area was collected and a visual assessment of instream cover was recorded to guide choice of specific release locations and to ensure that fish would be released at relatively low densities scattered throughout the release stream. In general, fish were released at approximately 0.5 fish/m^2.

Table 6. Summary of 2004 release. Average body sizes (standard error) are indicated for each release stream. The number of mortalities reported is the number of fish observed dead during release.

Release Date(s)	Release Stream	No. Released	Mean FL (mm)	Mean Wt. (g)	No. Mortalities
Oct 4-6, 2004	Ward Creek	1,775	101 (27)	14.1 (4.9)	5
Oct 18-22, 2004	Mill Creek	3,433	100 (24)	13.5 (4.1)	3
Nov 4, 2004	Sheephouse Creek	952	110 (41)	18.8 (11.6)	3

IV. B.2. 2005 release

Release seasons and tributaries

The 2005 release plan included releasing fish into all three of the 2004 release streams (Mill, Ward, and Sheephouse Creeks), plus two additional streams for the group of fish representing only the large family groups, described in Section IV.A. Due to increased juvenile production after the second spawning season, the release plan for 2005 also included both a spring and a fall release such that over-summer survival rates could be estimated in some release streams. The two additional streams chosen were Gray Creek, a tributary to East Austin Creek, and within the same drainage as Ward Creek, and Palmer Creek, a tributary to Mill Creek. Sheephouse, Palmer, and Gray Creeks were chosen to receive both a spring and fall release, while Ward and Mill Creeks would only be planted in the fall of 2005.

Tagging strategy

A tagging strategy had to be developed that would allow identification of up to three release groups at a single outmigrant trap. For example, the spring and fall release groups in Palmer Creek as well as the fall release group in Mill Creek would all be trapped at the downstream end of Mill Creek. The same situation applied to the Austin Creek system, where, at the downstream end of Austin Creek, fish from Gray Creek spring or fall releases, or the Ward Creek fall release might be captured. For the Sheephouse Creek trap, only two groups needed to be distinguishable: spring and fall releases.

The method chosen for batch-marking 3 different release groups was differential body locations of CWTs. All fish released in the spring (into Sheephouse, Palmer, and Gray Creeks) received a CWT in the snout location. Fish released in the fall received either a CWT in the peduncle location only (Mill, Ward, and Sheephouse Creeks) or in both the snout and peduncle locations

(Gray and Palmer Creeks). The location of the CWT(s) in a fish captured in an outmigrant trap could be determined with a handheld wand CWT-detector.

Release summary

In the spring of 2005, a total of 12,074 juveniles were released into Sheephouse, Palmer, and Gray Creeks. Specific reaches were chosen for the spring release and fish were released in fewer pools at higher density than they were for the 2004 fall release. The rationale for this difference was that connectivity between pools was higher in the late spring than during the fall, and we assumed that fish would have the opportunity to spread into adjacent habitat after release. Table 7 provides details of the spring release of 2005.

Table 7. Summary of 2005 release. Mean body sizes (standard error) are indicated, and the number of mortalities observed on the day of release.

Release Date	Release Stream	No. Released	Mean FL (mm)	Mean Wt. (g)	No. Mortalities
5/31/2005	Sheephouse Creek	7,024	56 (7)	2.5 (1.0)	14
6/9/2005	Palmer Creek	2,466	59 (6)	2.8 (0.9)	5
6/21/2005	Gray Creek	2,584	61 (7)	2.9 (1.1)	18

Part II: Monitoring Activities

V. Goals and Objectives of Monitoring Effort

As stated in section I.B.2., the overall goal of the monitoring component of the RRCSCBP is to evaluate juvenile coho release protocols in relation to stocking time (spring vs. fall) and stream environment in order to determine the optimal reintroduction methods for successfully reestablishing self-sustaining runs of coho in historic habitat within the Russian River drainage.

Specific objectives for 2004-2005 were as follows:

1) Evaluate the transition of juvenile hatchery-reared coho salmon from Warm Springs Hatchery into stocking streams.
2) Estimate the number and migration timing of coho smolts emigrating from stocked tributaries and an unstocked (comparison) tributary.
3) Estimate overwinter survival, size, and condition of coho that were released the previous fall.
4) Compare macroinvertebrate abundance among program streams as a measure of food availability for stocked coho.
5) Record continuous temperature and flow data on each program stream.

Monitoring activities were carried out on the three streams that were stocked in 2004 (Mill, Sheephouse, and Ward Creeks), and on two streams with remnant wild coho populations that served as comparison streams (Green Valley and Dutch Bill Creeks) (Figure 4). Monitoring data collected from October 1, 2004 (inception of monitoring activities) through June 30, 2005 are summarized in this report, including the RRCSCBP's first release of juvenile coho in the fall of 2004 through their downstream migration in spring of 2005.

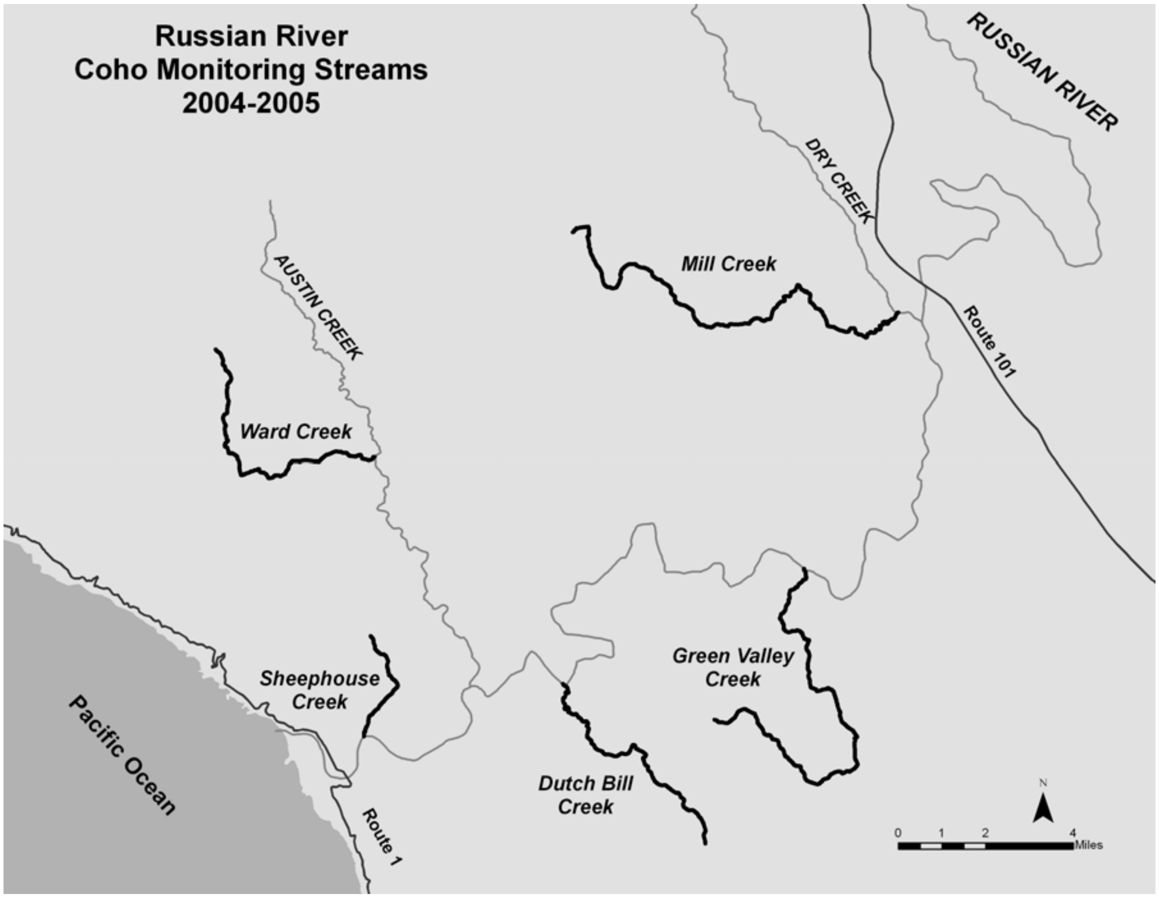

Figure 4. Coho streams monitored by UCCE (bold), 2004-2005.

VI. Transition of Released Coho from WSH into Streams

VI.A. Survival of fall-released coho in Ward and Sheephouse Creeks one week after stocking (Objective 1)

In order to evaluate the transition of juvenile hatchery-reared coho salmon from Warm Springs Hatchery into program streams, we estimated survival immediately after a stocking event (within the first week after stocking).

VI.A.1. Methods

Estimates of survival were obtained in selected habitat units on Ward and Sheephouse Creeks one week after the 2004 fall release. Prior to stocking in each creek, several pools were selected in lower, middle and upper reaches and netted off with block seines if they were not otherwise isolated. Known numbers of coho were subsequently stocked into each pool. After five to seven days, multiple-pass removal estimates were conducted using electrofishing and estimates of abundance in each pool were generated using Program MARK. A survival estimate was then generated for each pool by dividing the estimated number of fish in each pool after one week by the number originally stocked into the pool.

VI.A.2. Results and discussion

In Ward Creek, survival estimates ranged from 62% to 97% (Table 8). In Sheephouse Creek, survival estimates were higher than in Ward Creek, ranging from 80% to 100% (Table 8), and estimates were 92% or greater in five out of six pools. In both creeks, fish appeared to be in good condition with the exception of some scale loss which was likely caused by net handling during the transplant from the hatchery.

Variation in survival showed no relationship with reach, instream cover rating, or pool area (Table 8). In the two pools in Ward Creek where survival was lowest (62% and 75%, Table 8), otter or raccoon scat was observed on partially submerged boulders in the pools. We suspect that the increased mortality we observed there was caused by predation as opposed to handling and transplant into the pools.

In addition to survival estimates, qualitative evaluations were conducted by walking the streams and observing the pools 24 hours after stocking, and by snorkeling six pools on Ward Creek 24 to 48 hours after release. Coho were observed aggregating in the deepest sections of the pools and under the cover of large woody debris and boulders. On Ward Creek, one unhealthy, dark colored fish was found high in the water column. No mortalities were observed.

Target stocking densities for Ward and Sheephouse were 0.5 coho/m^2. Coho densities one week after release were close to the target in Sheephouse Creek (ranging from 0.31 to 0.47 coho/m^2, Table 9) and slightly lower than the target in Ward Creek (ranging from 0.14 to 0.24 coho/m^2, Table 9). In addition to mortality, the lower densities in Ward may have resulted from an increase in stream flow between the pre-stocking habitat survey and when the electrofishing samples were conducted.

In pools that were electrofished to estimate coho survival, data were also collected on steelhead density. Steelhead were counted and life stage was estimated (yoy or parr). In Ward Creek, steelhead yoy densities ranged from 0.22 to 0.48 fish/m^2. Steelhead parr densities were lower, ranging from 0.04 to 0.11 fish/m^2 (Table 9). Overall, steelhead densities were lower in Sheephouse than in Ward with Sheephouse yoy densities ranging from 0.02 to 0.14 fish/ m^2 and parr densities ranging from 0 to 0.06 fish/m^2 (Table 9). In nearly all pools examined on Ward Creek, coho densities were lower than steelhead yoy densities. The reverse was true on Sheephouse Creek.

High coho survival estimates one week after release indicate that the transition of juvenile coho from Warm Springs Hatchery into Ward and Sheephouse Creeks was successful. On this basis, we recommend that the same stocking methods be applied for future coho releases.

VI.B. Post-stocking monitoring of 2004 fall release on Mill Creek

VI.B.1.Methods

A different procedure than that used on Ward and Sheephouse Creeks was used on Mill Creek to evaluate the immediate effects of stocking on coho survival. Michael Fawcett (private consultant) conducted seining surveys on two reaches in Mill Creek before and after the coho stocking event (October 18-21, 2004). Approximately two weeks prior to stocking, steelhead from eight pools in a middle reach and eight pools in an upper reach were captured and counted using hand seines. Approximately three to four weeks after stocking, seining was repeated in each pool and numbers of both coho and steelhead were recorded.

VI.B.2. Results and discussion

In both the middle and upper reaches few coho were recaptured relative to the number stocked three to four weeks earlier (Table 10). In almost all of the pools, the percentage of coho recovered was low (0% to 35%) with the exception of two pools that had higher recovery rates (72% and 80%). Because the pools were not isolated with block seines between the stocking event and the post-stocking sampling event, we cannot determine whether the lower number of fish in the pools was caused by mortality or fish simply swimming out of the pools in which they were stocked. We suspect that the low recovery rates are a result of fish movement in relation to a rain event during and immediately after stocking rather than high mortality rates.

Table 8. Abundance (one week after stocking) and survival (during the first week after stocking) estimates for juvenile coho salmon released into Ward Creek on October 4-6 and Sheephouse Creek on November 4, 2004.

Tributary	Pool	Reach	Instream cover*	Pool area (m^2)	Coho stocked	Coho recaptured	Abundance (95% CI)	Survival (95% CI)
Ward	3	lower	1	282	50	59	59 (59-59)	n/a**
Ward	40	middle	2	266	60	37	37 (37-37)	0.62 (0.62-0.62)
Ward	57	middle	2	95	24	18	18 (18-18)	0.75 (0.75-0.75)
Ward	67	upper	2	244	60	54	58 (55-72)	0.97 (0.91-1.21)
Ward	68	upper	1	150	30	29	29 (29-29)	0.97 (0.97-0.97)
Sheephouse	11	lower	1	49	25	23	23 (23-23)	0.92 (0.92-0.92)
Sheephouse	26-27***	middle	1	51	25	24	24 (24-24)	0.96 (0.96-0.96)
Sheephouse	41	middle	2	36	15	14	14 (14-14)	0.93 (0.93-0.93)
Sheephouse	55	upper	1	22	10	10	10 (10-10)	1.00 (1.00-1.00)
Sheephouse	56	upper	2	26	10	8	8 (8-8)	0.80 (0.80-0.80)

* Rated between 0 and 3 (0=low, 3=high).

** A survival estimate could not be calculated because the upstream end of pool 3 was not netted and fish moved in from upstream.

*** Fish were able to pass through the net separating pools 26 and 27 so these pools were treated as a single pool for abundance and survival estimates.

Table 9. Estimated juvenile coho and young of year (yoy) and parr steelhead (Sth) densities in Ward and Sheephouse Creeks one week after fall coho release 2004 .

Tributary	Pool	Reach	Instream cover	Coho density (fish/m^2) (95% CI)	Sth yoy density (fish/m^2) (95% CI)	Sth parr density (fish*m^{-2}) (95% CI)
Ward	3	lower	1	0.21 (0.21-0.21)	0.07 (0.07-0.07)*	
Ward	40	middle	2	0.14 (0.14-0.14)	0.78 (0.74-0.88)*	
Ward	57	middle	2	0.19 (0.19-0.19)	0.37 (0.33-0.57)	0.04 (0.04-0.04)
Ward	67	upper	2	0.24 (0.22-0.3)	0.48 (0.42-0.66)	0.08 (0.08-0.08)
Ward	68	upper	1	0.19 (0.19-0.19)	0.22 (0.21-0.31)	0.11 (0.11-0.11)
Sheephouse	11	lower	1	0.47 (0.47-0.47)	0.06 (0.06-0.06)	0
Sheephouse	26-27**	middle	1	0.47 (0.47-0.47)	0.02 (0.02-0.02)	0.02 (0.02-0.02)
Sheephouse	41	middle	2	0.39 (0.39-0.39)	0.06 (0.06-0.06)	0.06 (0.06-0.06)
Sheephouse	55	upper	1	0.45 (0.45-0.45)	0.14 (0.14-0.14)	0
Sheephouse	56	upper	2	0.31 (0.31-0.31)	0.04 (0.04-0.04)	0

* Steelhead yoy and parr were combined for density estimates.

** Fish were able to pass through the net separating pools 26 and 27 so these pools were treated as a single pool for density estimates.

Table 10. Coho and steelhead juveniles captured in Mill Creek before and after coho release, fall 2004.

Middle Reach

Pool	Coho Stocked (Oct 21)	Coho Recaptured (Oct 29)	Percent coho recovered	Steelhead prestocking (Oct 5)	Steelhead post stocking (Oct. 29)
41	10	0	0	7	6
42	70	4	6	11	7
45	80	4	5	0	2
47	40	7	18	20	17
48	15	1	7	9	12
51	45	2	4	5	4
52	20	7	35	8	12
53	5	4	80	3	11

Upper Reach

Pool	Coho Stocked (Oct 18)	Coho Recaptured (Nov 3)	Percent coho recovered	Steelhead prestocking (Oct 4)	Steelhead post stocking (Nov 3)
150	40	1	3	5	14
151	25	5	20	10	10
158	32	23	72	9	11
162	35	4	11	13	8
164	40	10	25	2	6
166	15	5	33	5	4
173	10	1	10	11	7
175	25	0	0	2	4

VII. Smolt Abundance and Overwinter Survival

V.II.A. Downstream migrant trapping on Mill, Sheephouse, Ward, and Green Valley Creeks, spring 2005 (Objectives 2 & 3)

Downstream migrant traps were operated on Mill, Ward and Sheephouse Creeks to (1) estimate the number and migration timing of coho smolts leaving each system, and (2) evaluate overwinter survival and growth of coho that were released the previous fall. For comparison, a downstream migrant trap was also operated on Green Valley Creek (where no hatchery fish were released) to estimate wild smolt production. Secondary project objectives were to estimate the number of steelhead smolts emigrating from each creek, collect genetic samples from coho and steelhead, and count all other fish species passing through the traps.

V.II.A.1. Methods

Funnel traps were used on Mill, Ward, and Green Valley Creeks and a pipe trap was used on Sheephouse Creek (Figures 5a and 5b). The funnel traps included removable weir panels constructed of either aluminum framing with metal conduit or wooden framing with vexar screening. Each weir led into an 18' modified fyke or "funnel" net which was connected to a 3' section of 6" PVC pipe at the cod end and led into a 3'x 4' wooden-framed holding box. V-shaped flow deflectors were placed inside the holding boxes to provide fish with relief from the current during high flows. Trap sites were located near the mouths of the creeks to sample as much habitat as possible. The mouth of each trap was placed at the downstream end of a riffle and the cod end of the net and holding box were placed in calmer water. On Sheephouse Creek, the pipe trap used consisted of a vexar weir placed at the tailout of a pool which channeled water into a 40' section of 6" PVC pipe leading into a holding box similar to the traps used on the other three creeks.

The traps were installed between 3/9/05 and 3/17/05 and were operated until 6/10/05 (Ward and Green Valley), 6/19/05 (Mill), and 6/20/05 (Sheephouse). During several high flow/storm events throughout the spring, the weirs and traps were either pulled or washed out and did not fish until the high flows subsided. Traps were checked seven days a week by UCCE staff with the help of partnering agency volunteers.

To estimate the abundance of downstream migrating coho smolts, a capture-mark-recapture (CMR) study was conducted on each creek. On each stream, up to 15 coho were marked daily with a fin clip and released at a minimum of two pool/riffle sequences upstream of the trap. A different fin clip was applied each week based on a four week rotation. This required the assumption that marked fish would not take longer than four weeks to re-emigrate after release upstream. The proportions of marked and unmarked fish captured in the traps were used to estimate weekly trap efficiencies, and, in turn, seasonal smolt abundance using Program DARR (Bjorkstedt 2000, Bjorkstedt 2005, CDFG 2003).

Traps were checked a minimum of one time per day when in operation. Each day upon arrival, fish were netted into aerated buckets for sampling work-up. Coho and steelhead smolts were anesthetized in a bucket containing water and Alka Seltzer and measured for length and weight. Every new fish was checked for the presence of an adipose fin clip to determine whether it was a hatchery-released program fish (adipose fin clipped) or a wild fish (no adipose fin clip). For the CMR study, a maximum of 15 newly captured fish received a caudal fin clip each day. Tissue from the fin clip was preserved for genetic analysis. For recaptured coho, the fin clip was recorded and the fish were immediately released downstream to minimize processing time. Coho, Chinook and steelhead yoy were measured for length and weight (up to 15 individuals per species per day). All other fish (and other species) were tallied. After processing, fish were placed in aerated buckets for recovery and then released downstream of the trap. Before leaving the trap site, debris was removed from the weir, net and box, and the trap was inspected for holes or other potential problems.

V.II.A.2. Results and discussion

Trap counts and run-timing

A total of 1,019 program coho and 11 non-program (no adipose clip) coho smolts were captured in Green Valley, Mill, Sheephouse and Ward Creeks (Table 11). Coho smolts first appeared in the traps on 4/1/05 (Mill and Sheephouse) and the run continued until mid-May (Green Valley and Ward) or mid-June (Mill and Sheephouse) (Figure 6). Based on our trap count, the peak of the run for all streams occurred during the last week of April through the second week of May. In Sheephouse Creek 56% of the run was captured on 5/8 and 5/9 revealing a steeper peak than the other tributaries.

In addition to coho, a total of 172 steelhead smolts, 4,418 steelhead yoy/parr, 11 steelhead adults, and 888 Chinook yoy were captured in the traps (Table 12). Adipose clips were observed on eight of the steelhead smolts (7 on Mill, 1 on Sheephouse), indicative of their hatchery origin. A number of other native and non-native fish and other species were also captured in the traps (Tables 13, 14).

Coho abundance and overwinter survival estimates

Estimates of smolt abundance were highest on Mill Creek; this was expected given the higher number of fish stocked into Mill Creek the previous fall (Table 15, Figure 7a). Estimates of overwinter survival were also highest for Mill and slightly lower for Sheephouse (Table 15, Figure 7b). Abundance and overwinter survival estimates were lowest for Ward Creek; however, the Ward Creek trap was inoperable for longer periods of time than traps on the other creeks due to high flow conditions (Figure 6). These gaps in data collection may have resulted in a biased estimate if coho emigrated before the trap was re-installed.

Capture of wild coho (no adipose fin clips)

Nine coho smolts without adipose fin clips were caught on Green Valley, and four of these were likely age-2+ (FL > 165, weight > 40g). Two unclipped coho smolts were also caught on Mill Creek. One of these fish was tested for presence of a coded wire tag (CWT) to determine whether the fish was a program fish that simply did not receive a clip. It did not have a tag, suggesting that the fish was of wild origin. The CWT detector was not available to test the second unclipped fish captured on Mill Creek. Twenty-five unmarked coho yoy were also captured on Mill Creek, four of which were transported to Warm Springs Hatchery. One coho yoy was captured and released on Ward Creek.

Spring-released coho yoy

After the spring release of coho yoy on Sheephouse Creek on 5/31/05, an approximate total of 3,348 coho fry were captured in the Sheephouse trap. The majority of them were captured in the first three days after the release (1,770 on 6/1, 750 on 6/2, and 173 on 6/3). Following the first three days after the release, less than 15/day were found in the trap until the trap was removed on 6/20/05. An exception was on 6/8/05 when a rain event appeared to trigger another pulse of coho fry as another 570 were found in the trap on 6/9/05. On days where more than 100 coho fry were found in the trap, they were restocked upstream of the weir. If there were less than 100, they were released downstream of the trap. On Mill Creek, one adipose-clipped coho fry was caught in the trap, a few days after the spring release of coho fry on Palmer Creek.

Salmonid growth and condition

Average fork length and weight were similar for coho smolts captured in Mill and Sheephouse Creeks and smaller for coho captured in Ward Creek (Figure 8a, 8b). Condition factor was similar for smolts captured in all three tributaries (Figure 8c). Length frequency distributions were similar between Mill and Sheephouse, but showed a greater proportion of smaller size-classes on Ward (Figure 9). The few coho that were captured on Green Valley were larger than the majority of coho captured in the other tributaries (Figure 9). Average smolt size remained similar throughout the trapping period, with a possible slight decrease over the season (Figure 10).

Length-frequency distributions of juvenile steelhead (yoy and parr) revealed differences among the four tributaries (Figure 11). Young of the year captured in Green Valley appear to be larger than those captured in Mill or Ward Creeks. In Ward and Sheephouse Creeks multiple modes are apparent, whereas in Mill and Green Valley, very few fish were captured above a given size class (varying by creek). A number of factors could have caused higher proportions of larger fish in some of the tributaries compared to others. Possibilities include a higher proportion of older year classes, earlier spawning dates, or higher growth opportunity.

Genetic samples

Genetic samples were collected on 732 coho smolts, and 230 steelhead (162 smolts, 68 parr). These samples were delivered to Carlos Garza at the Southwest Fisheries Science Center, NOAA Fisheries, Santa Cruz where they will be processed and analyzed.

Trap-related mortality

Measures were taken to minimize mortality of salmonids captured in the downstream migrant traps including frequent (at least daily) checking of traps and removal of debris, installation of flow deflectors inside of the box to provide relief from the current, and removal of the traps during high flow events. Despite these efforts, mortality of salmonids at various life stages occurred (Table 16). The primary cause was high flows during unpredicted storm events when we were not able to reach all of the traps. Two of the three adult steelhead mortalities were spawned out kelts that were found near death in the trap box (we do not think their poor condition was caused by trapping). The third was a trap design related mortality that was immediately modified to prevent reoccurrence of the problem.

a.

b.

Figure 5. Trap designs used on Mill Creek (a) and Sheephouse Creek (a) in 2005. The funnel trap used on Mill was similar to designs used on Ward and Green Valley while the pipe trap design was only used on Sheephouse.

Table 11. Number of coho smolts captured in downstream migrant traps, spring 2005.

Tributary	Program	Non-program (no adipose fin clip)	Total
Green Valley	6	9	15
Mill	632	2	634
Sheephouse	294	0	294
Ward	87	0	87
Total	1019	11	1030

Table 12. Number, species and life stage of salmonids captured in downstream migrant traps, spring 2005.

Species	Life stage	Green Valley	Mill	Sheephouse	Ward	Total
Chinook	yoy	817	69	2	0	888
coho	smolt	15	634	294	87	1,030
coho	yoy	0	25	3,348*	1	26
steelhead	adult	1	9	0	1	11
steelhead	smolt	49	103	15	5	172
steelhead	yoy/parr	1,723	1,904	123	668	4,418

*These fish were hatchery coho released into Sheephouse on May 31, 2005.

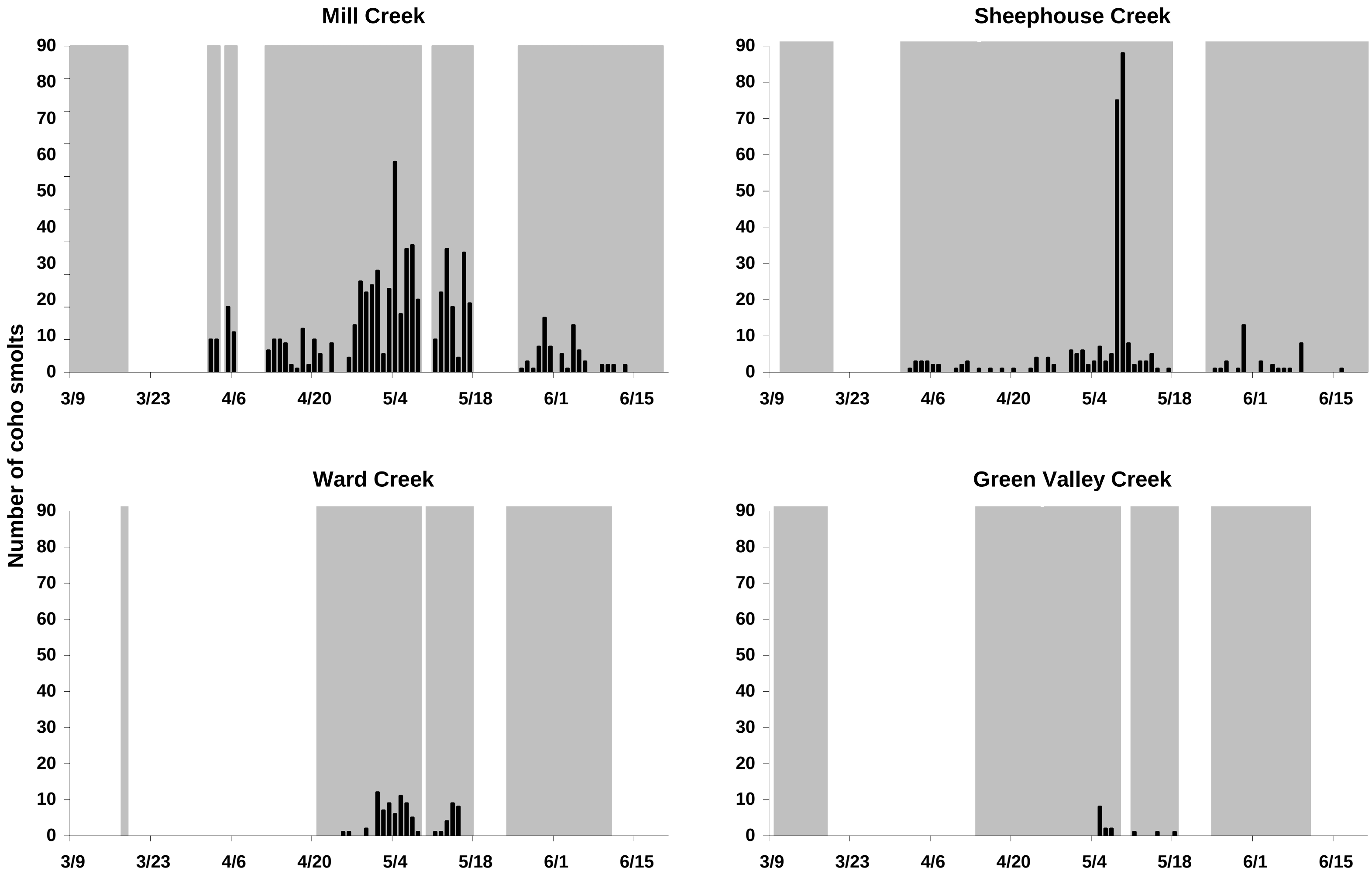

Figure 6. Coho smolts captured in downstream migrants traps durning spring 2005 on tributaries of the Russian River. Shaded background signifies days that the traps were fishing.

Table 13. Native and non-native fish species captured in downstream migrant traps in 2005.

Common name	Scientific name	Green Valley	Mill	Sheephouse	Ward
	native				
hardhead	*Mylopharodon conocephalus*	147	45	18	6
hitch	*Lavinia exilicauda*	2	0	0	0
Lamprey sp.	*Lampetra sp.*	32	48	0	0
Pacific lamprey	*Lampetra tridentata*	0	8	0	1
pike minnow	*Ptychocheilus grandis*	62	29	44	0
roach	*Lavinia symmetricus*	211	110	36	59
Sacramento sucker	*Catostomus occidentalis*	53	100	98	4
Sculpin sp.	*Cottus sp.*	371	895	1635	866
three-spined stickleback	*Gasterosteus aculeatus*	1699	0	1	4
tule perch	*Hysterocarpus traski*	3	0	0	0
Western brook lamprey	*Lampetra richardsoni*	5	3	0	0
Sacramento blackfish	*Orthodon microlepidotus*	3	0	0	0
	non-native				
black crappie	*Pomoxis nigromaculatus*	2	0	0	0
bluegill	*Lepomis macrochirus*	627	54	0	0
fathead minnow	*Pimephales promelas*	15	22	0	0
green sunfish	*Lepomis cyanellus*	40	35	0	0
large mouth bass	*Micropterus salmoides*	1	6	0	0
small mouth bass	*Micropterus dolomieu*	0	2	0	0
white crappie	*Pomoxis annularis*	11	2	0	0
yellow bullhead	*Ameiurus natalis*	3	0	0	0

Table 14. Non-fish species captured in downstream migrant traps in 2005.

Common name	Scientific name	Green Valley	Mill	Sheephouse	Ward
bullfrog*	*Rana catesbeiana*	5	13	0	0
bullfrog tadpole*	*Rana catesbeiana*	5	653	0	0
Foothill yellow legged frog	*Rana boylii*	0	0	0	126
Tree frog sp.	*Hyla sp.*	3	0	0	0
unknown frog		14	33	2	10
unknown tadpole		34	111	0	0
Western toad	*Bufo boreas*	51	8	0	0
rough skinned newt	*Taricha granulosa*	19	0	0	0
Western pond turtle	*Clemmys marmorata*	2	0	0	0
Red-eared slider turtle*	*Trachemys scripta elegans*	1	0	0	0
Turtle sp.		1	1	0	0
California freshwater shrimp	*Syncaris pacifica Holmes*	8	0	0	0
unknown crayfish		60	1	0	22
mallard	*Anas platyrhynchos*	3	11	0	0
Common merganser	*Mergus merganser*	0	4	0	0

*Non-native to California

Table 15. Smolt abundance and overwinter apparent survival estimates for coho juveniles released in fall 2004.

Tributary	Number stocked	Trap Count	Smolt abundance (95% LCI-UCI)	Overwinter survival (95% LCI-UCI)
Mill	3,433	634	1,906 (1,567 – 2,246)	0.56 (0.46 - 0.65)
Sheephouse	952	292	415 (375 - 456)	0.44 (0.39 - 0.48)
Ward	1,775	87	190 (145 - 234)	0.11 (0.08 - 0.13)
Total	6,160	1,013	2,511 (2,087 – 2,936)	0.41 (0.34 - 0.48)

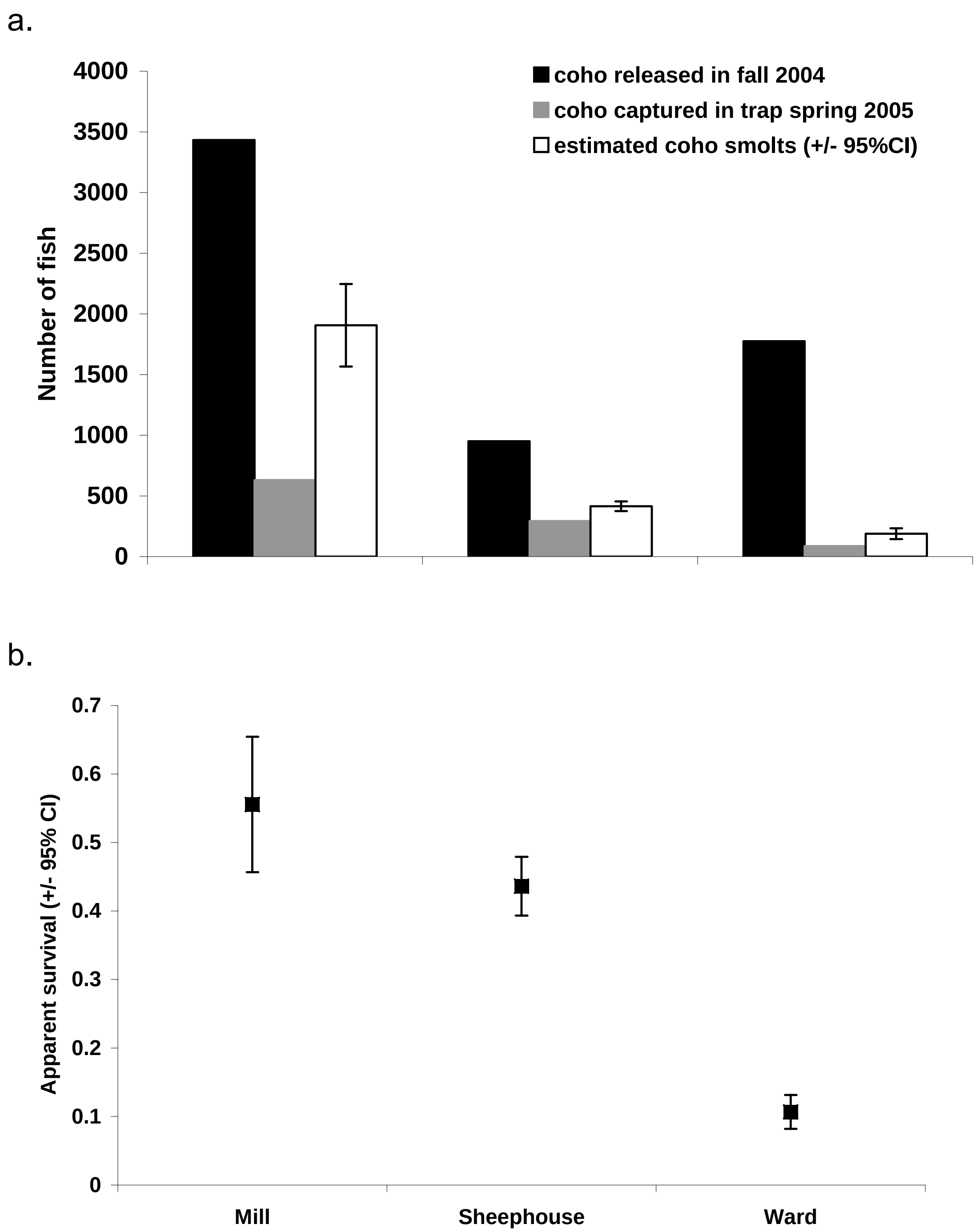

Figure 7. Number of juvenile coho released in fall 2004 and subsequent spring trap counts and abundance estimates (a) and overwinter apparent survival (b).

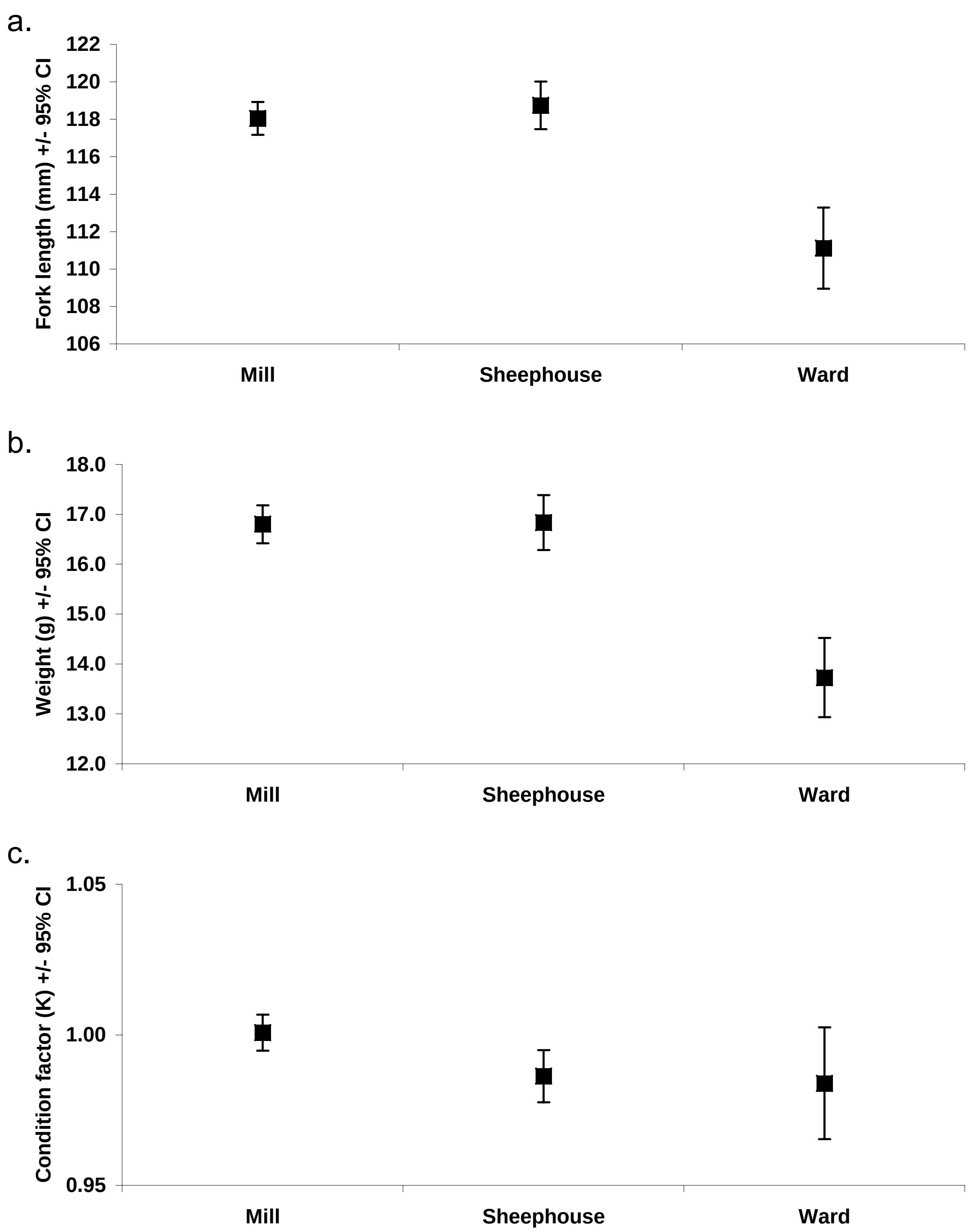

Figure 8. Mean fork length, weight, and condition factor of program coho smolts captured in downstream migrant traps, spring 2005. Sample sizes are as follows, Mill: 576, Sheephouse: 256, Ward: 86.

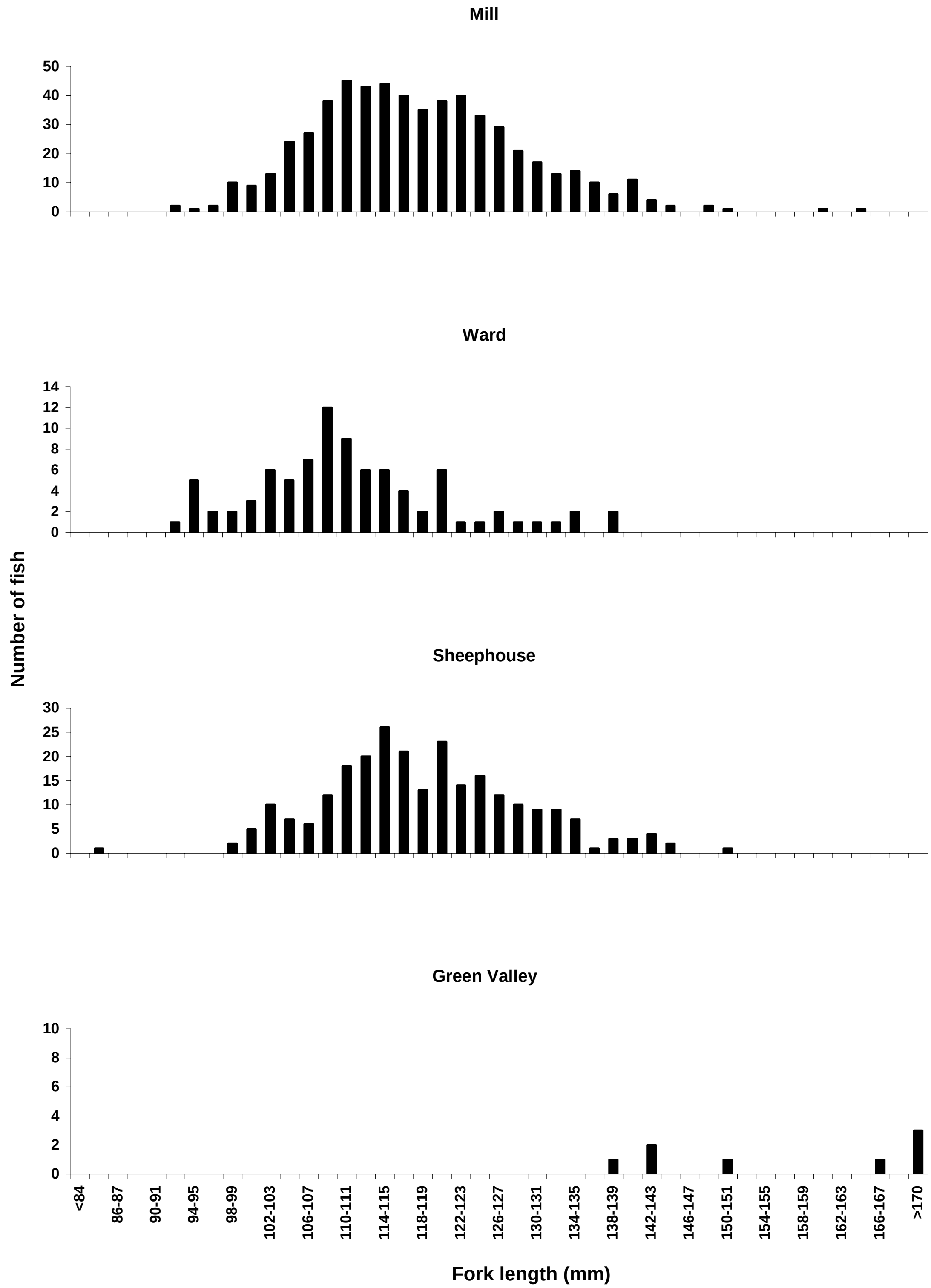

Figure 9. Length-frequency distributions for hatchery coho smolts captured in downstream migrant traps, spring 2005. Green Valley coho are non-program fish (no adipose fin clip).

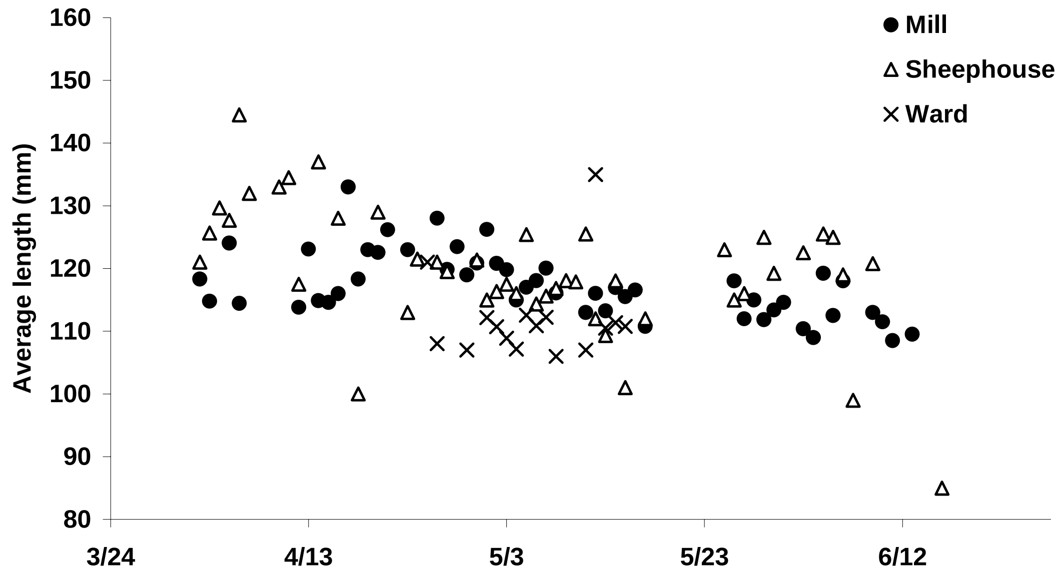

Figure 10. Daily average length for coho smolts captured in downstream migrant traps, spring 2005.

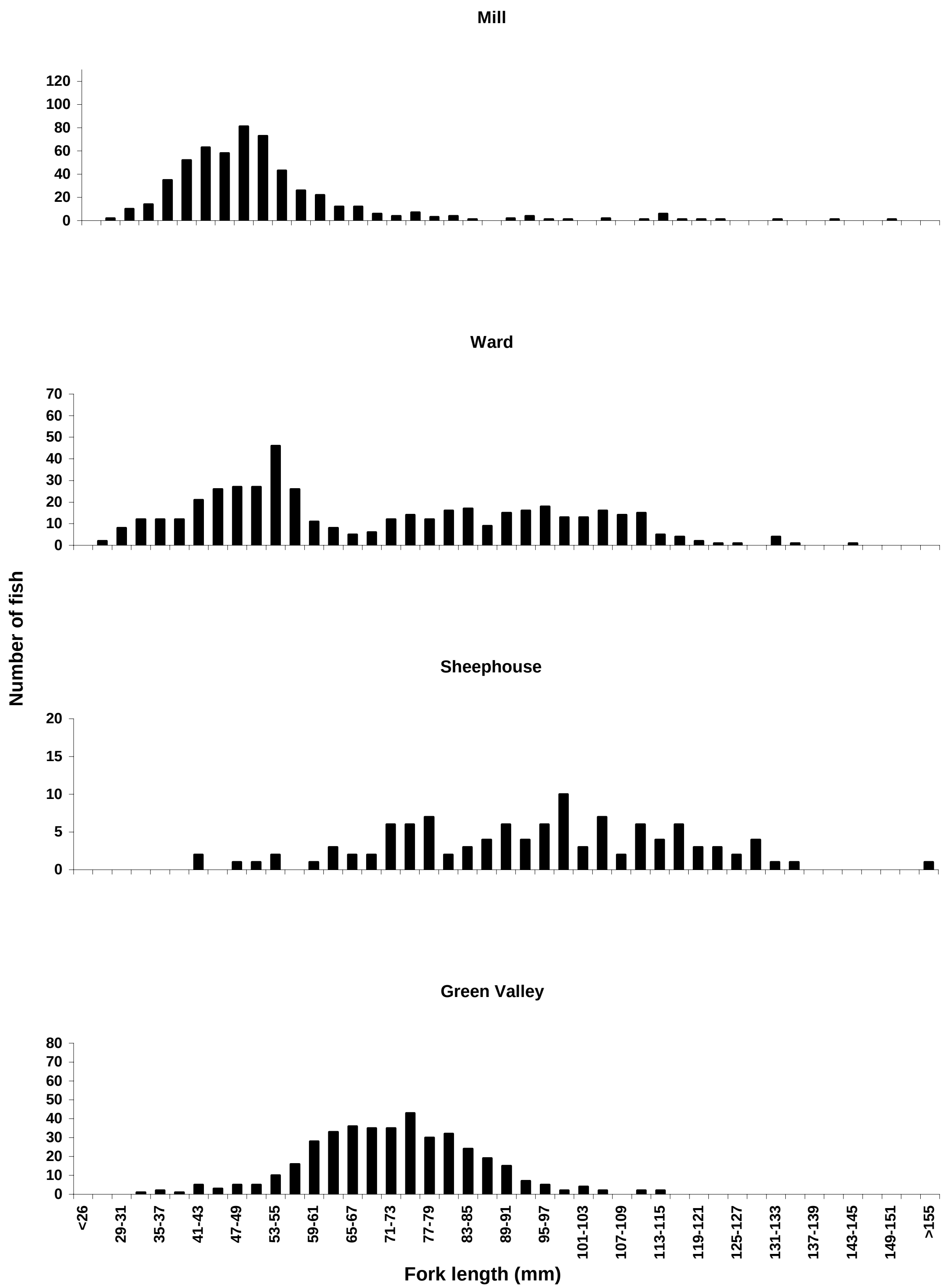

Figure 11. Length-frequency distributions for juvenile steelhead non-smolts (yoy and parr) captured in downstream migrant traps, spring 2005.

Table 16. Salmonid mortalities observed in downstream migrant traps, spring 2005.

	Coho		Steelhead			Chinook	Unk salmonid
Tributary	**yoy**	**smolt**	**yoy**	**smolt**	**adult**	**yoy**	**yoy**
Green Valley	0	1	1	1	0	5	0
Mill	6	6	1	1	3	1	2
Sheephouse	0	4	1	0	0	0	0
Ward	0	0	2	0	0	0	0

VIII. Comparing food availability among program streams

VIII.A. Benthic macroinvertebrate (BMI) sampling (Objective 4)

During the spring and summer of 2005, we compared macroinvertebrate abundance among program streams as a measure of food availability for stocked coho. This is the first step in environmental data collection for comparisons with coho population data which will eventually provide insights into the successes or failures on a stream-by-stream basis relative to ecological condition of the streams and food availability for supplemented fish.

VIII.A.1. Methods

In order to compare food abundance for juvenile coho in program streams, benthic macroinvertebrate sampling was conducted on Mill, Sheephouse, and Ward Creeks during the spring of 2005. Samples were collected monthly between May and July in lower, middle and upper reaches on each stream. On each sampling date, three drift samples (within an hour of sunrise, midday, and sunset) and three benthic samples (at three randomly selected transects within a 100m stream section) were collected in each reach for a total of 54 samples per stream over a three month period.

Drift sampling at each site entailed setting two 500 µm drift nets across the channel transect that represented the major drift path of organisms. After 30 minutes, the nets were pulled out of the water. The content from each net was then combined to form one composite sample. During the 30 minute sample collection period, flow into each net was calculated by measuring the depth, width, and average velocity of water flowing into the net. Benthic samples were collected in each reach using a Hess sampler (500 µm mesh). At each randomly selected transect, three samples were collected (at right bank, at left bank, and at mid-channel) and then combined to form one composite sample. All samples were stored in 70% ethanol for later analysis. After sample collection, debris was separated from the invertebrates with the aid of a dissecting microscope. Cleaned and sorted samples were then shipped to EcoAnalysts for dry weight determination.

VIII.A.2. Results and Discussion

For benthic samples, mean dry weight (averaged over all samples, reaches, and transects) was highest in Mill Creek (Figure 12). Values in the other two creeks were similar, with Ward slightly higher than Sheephouse. Mean dry weights for drift samples were also highest in Mill Creek; however, there was a high level of variability among sample date, sample time, and reach (Figure 13). Unlike the pattern seen with benthic sample collection, drift samples collected in Ward had lower mean dry weights than those collected in Sheephouse.

Figure 12. Mean dry weights of benthic samples collected on three coho monitoring tributaries, spring 2005.

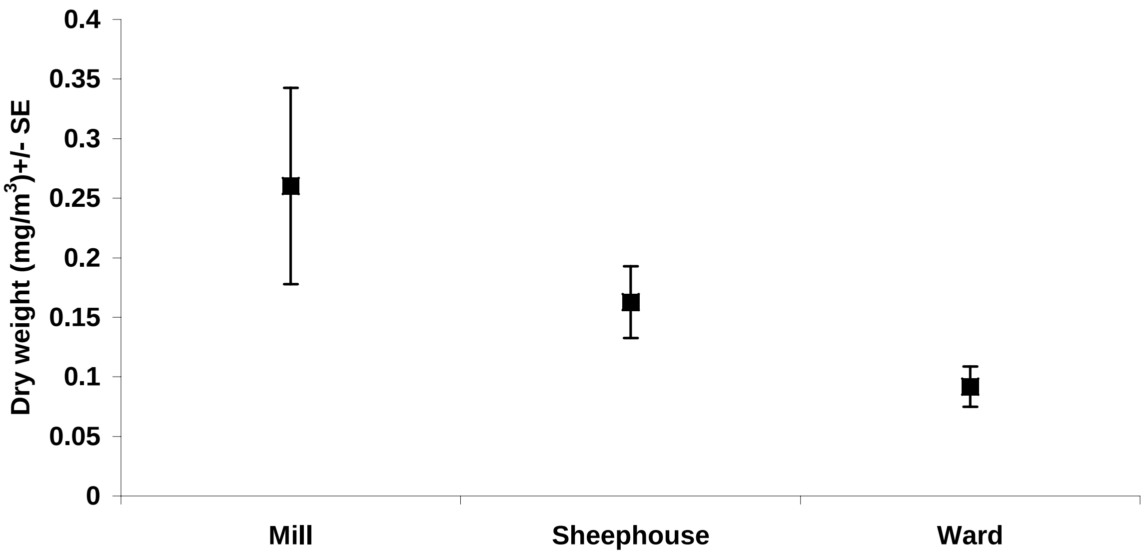

Figure 13. Mean dry weights of drift samples collected on three coho monitoring tributaries, spring 2005.

IX. Monitoring Flow and Temperature

IX.A. Monitoring flow (Objective 5)

IX.A.1. Methods

In order to document and compare patterns in flow among stocked streams and streams that sustain wild coho populations, Global Water water level loggers were installed at or near the mouths of Mill, Ward, Sheephouse, and Dutch Bill Creeks during the spring of 2005. Installation of instrumentation in Green Valley was delayed until fall of 2005 because of a delay in permitting/landowner permission. These meters record stage height on an hourly basis year-round. Discharge at various stage heights was estimated by multiplying the average stream velocity (measured with a Global Water flow probe) by the area of a cross section of the stream channel (calculated by multiplying stream width by average stream depth) (Mosley and McKerchar 1993). Regression was used to develop a relationship between stage height and discharge to estimate hourly discharge from stage height recordings.

IX.A.2. Results and Discussion

The 2004-2005 storm season witnessed both extreme events and an extension of the season into summer months. On March 19 and again 21 and 22, 2005 the Russian River and Northern California experienced rainstorms that in some locations deposited a combined 6 inches of rainfall. This resulted in rapid streamflow increases in both the Russian River mainstem and its tributaries. In Mill Creek, for example, stream flow reached a peak of 1,019 cfs on March 19 and 3,739 cfs on March 21 (Figure 14). In addition to these two events, rainfall continued uncharacteristically into late May and early June 2005, resulting in elevated streamflow values well into June.

Streamflow in each of the program streams demonstrated this response to the large storm events and the prolonged season of rainfall but differed in overall scale (Figure 15). Mill and Ward creeks generated the greatest streamflow of all the streams primarily due to their relatively larger drainage areas. In the case of Ward Creek it may also be that coastal proximity and greater slopes within that drainage contributed to greater precipitation amounts and thus streamflow. By comparison, streamflow in Sheephouse was consistently lower during extreme events and into the summer, as a result of its relatively smaller drainage area. As one of the habitat characteristics that will contribute to understanding the program's success, it will be important to make comparison between years and respective seasons between years to understand how extreme events and changes in summer and winter streamflow may influence program coho survival.

IX.B. Monitoring temperature (Objective 5)

IX.B.1. Methods

In order to document and compare patterns in temperature among stocked streams and streams that sustain wild coho populations, temperature was recorded continuously on Mill, Ward, Sheephouse, Dutch Bill, and Green Valley Creeks using Global Water and/or Onset instrumentation. Global Water instrumentation installed at or near the mouths of each tributary to measure stage height also recorded year-round hourly temperature on Mill, Ward, Sheephouse, and Dutch Bill Creeks. In addition, these four streams and Green Valley were instrumented with Onset Hobo Temp or Optic StowAway loggers. On each creek, temperature loggers were deployed in lower, middle, and upper reaches (three loggers per stream) to enable within-stream temperature comparisons. The Onset loggers were deployed in the spring (April-June) and removed in the fall (October-November). Stream audits were performed three times over the summer season to download data and recalibrate instrumentation.

IX.B.2. Results and Discussion

During this reporting period, running weekly average temperatures at lower reaches never fell below 10°C or above 19.7°C (Figure 16), and running weekly maximum temperatures never fell below 10.9°C or above 20.9°C (Figure 17). All creeks showed a similar pattern of increasing temperature from winter to late spring. Running weekly average temperatures were consistently highest on Mill and Ward, and lowest on Sheephouse. Trends in running weekly maximum temperatures were similar to running weekly averages with the exception that Ward Creek was higher than Mill from late May to early June. Within-stream temperature comparisons among reaches will be shown in the next reporting period when sufficient data has been collected at this scale.

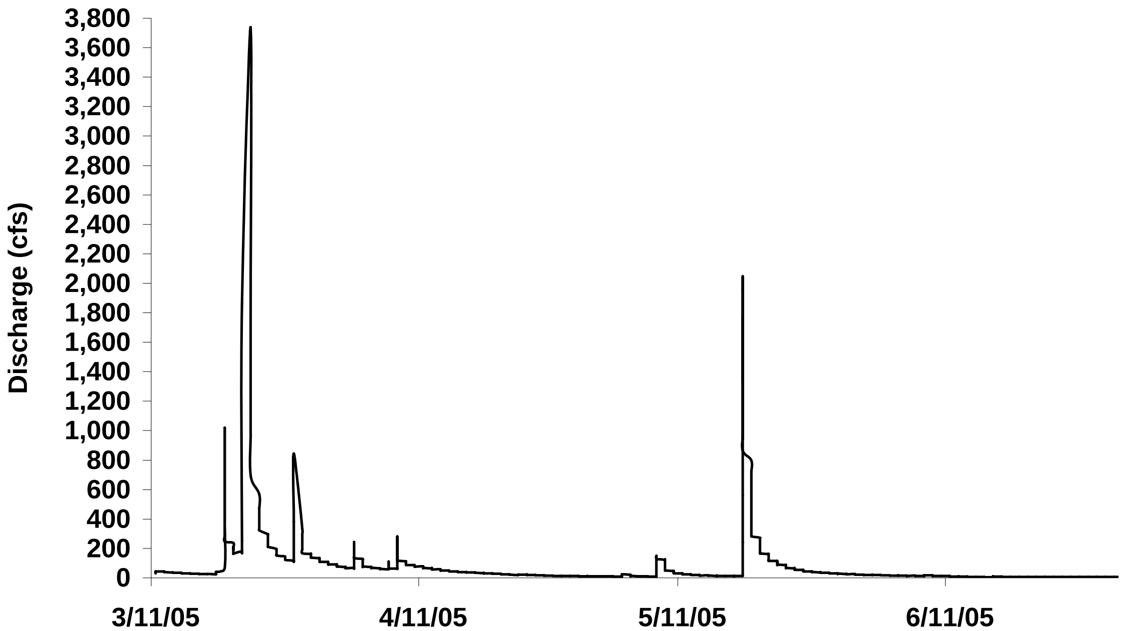

Figure 14. Stream discharge for Mill Creek from March 11, 2005 through June 30, 2005.

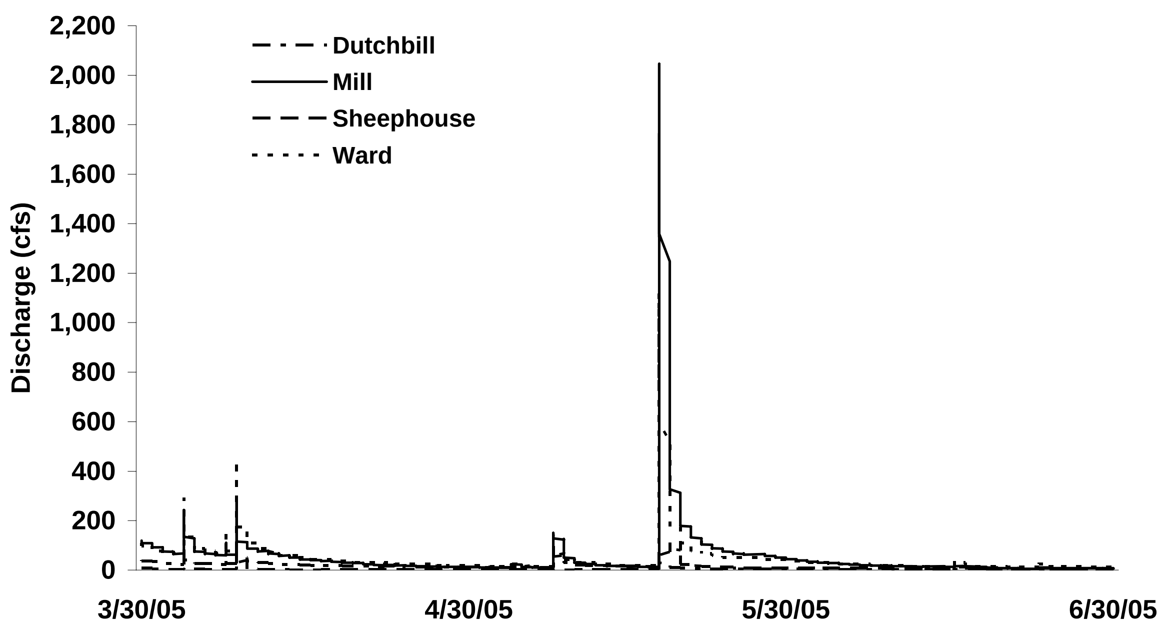

Figure 15. Stream discharge of coho monitoring streams from March 30, 2005 to June 30, 2005.

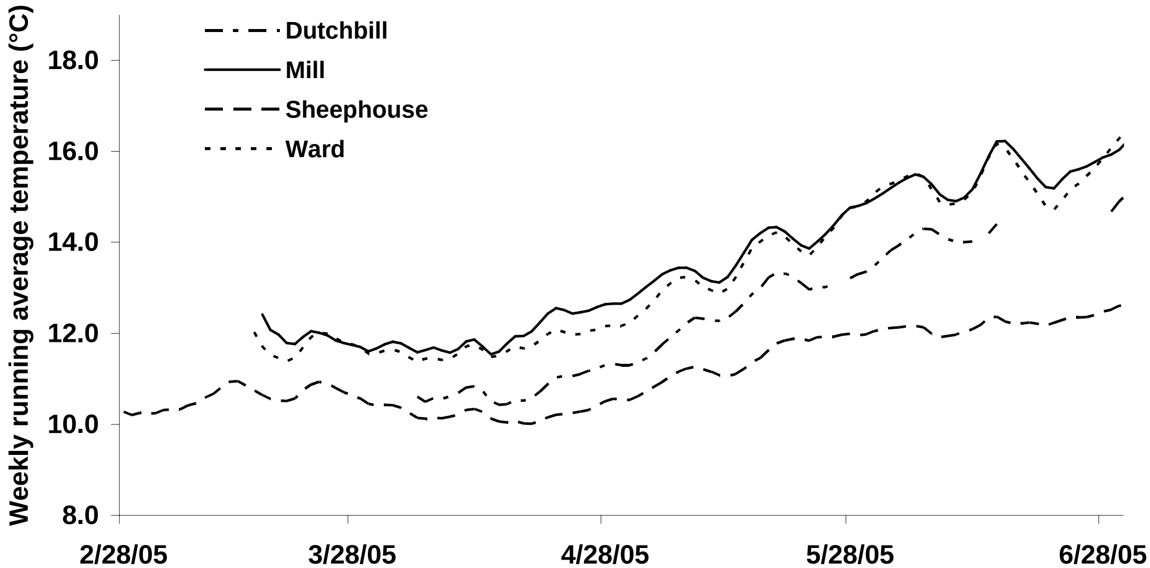

Figure 16. Weekly running average temperature (°C) at lower reach sites from February 28, 2005 to June 30, 2005.

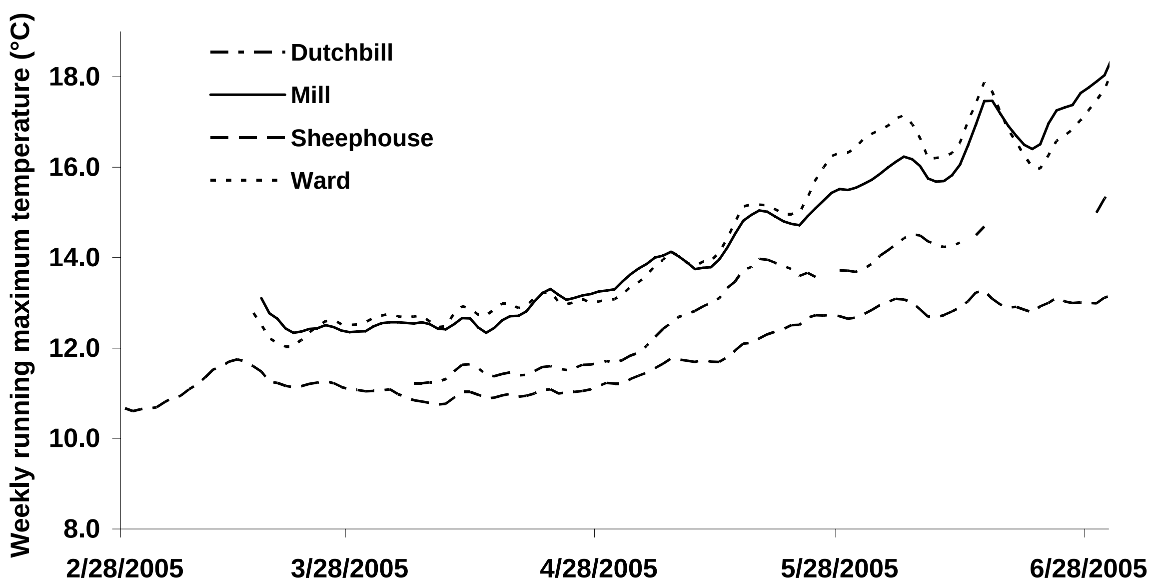

Figure 17. Weekly running maximum temperature (°C) at lower reach sites from February 28, 2005 to June 30, 2005.

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Appendix I: Summary of RRCSCBP Broodstock Growth Data

Since the spring of 2004, hatchery staff has collected body size data (fork length, weight) for each brood year every three to four months. The purpose of this work is to verify the broodstock inventory, assess fish health, obtain accurate tank biomass data to ensure target feeding rates and consistent feeding rates between tanks, as well as to compile a long-term dataset of broodstock growth for comparison of growth among brood years and stock origin. Tables A1.1 and A1.2 provide the dates of data collection and summarized body size data, respectively. After the addition of the large, 20' diameter circular tanks which resulted in enhanced growth for BY 2001 and BY2002, body size between brood years has been fairly consistent.

Table A1.1. Dates of body size data collection for brood years 2000 – 2003, through June 30, 2005. Seasons are defined as follows: "Winter" = January – March, "Spring" = April – June, "Summer" = July – August, and "Fall" = September – December. "nd" = no data.

Age	**1+**				**2+**			
Season	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
BY2000	nd	nd	nd	nd	nd	nd	nd	nd
BY2001	nd	nd	nd	nd	3/16,17/2004	4/6	6/28, 29/2004	9/28, 29/2004
BY2002	2/4, 6/2004	5/19/2004	nd	9/7, 9/2004	nd	4/11,13/2005	7/12, 14/2005	9/13,14/2005
BY2003	1/31, 2/2/2005	6/29, 30/2005	nd					

Table A1.2. Seasonal mean (standard error) fork length (FL) and weight for each brood year.

Age	1+							
Season	**Winter**		**Spring**		**Summer**		**Fall**	
Brood Year	FL (mm)	Wt. (g)	FL (mm)	Wt. (g)	FL (mm)	Wt. (g)	FL (mm)	Wt. (g)
2000	******no data*****							
2001	******no data*****							
2002	133 (1)	31 (1)	203 (1)	114 (2)	*****no data*****		274 (1)	330 (5)
2003	145 (2)	43 (2)	202 (2)	123 (4)	*****no data*****		293 (2)	392 (10)

Age	2+								3+	
Season	**Winter**		**Spring**		**Summer**		**Fall**		**Spawner**	
Brood Year	FL (mm)	Wt. (g)	FL (mm)	Wt. (g)	FL (mm)	Wt. (g)	FL (mm)	Wt. (g)	FL (mm)	Wt. (g)
2000	******no data*****								462 (3)	1129 (30)
2001	374 (2)	660 (18)	476 (2)	1171 (17)	*****no data*****		533 (3)	2409 (35)	553 (4)	2498 (41)
2002	*****no data*****		420 (2)	1082 (13)	490 (3)	1665 (28)	535 (3)	2310 (44)	586 (4)	2457 (54)

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